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by Harold E. Neustadter, Steven M. Sidik, Robert B. King, J. Stuart Fordyce, and John C. Burr

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16. Abstract

The Air Pollution Control Division of Cleveland, Ohio, and NASA Lewis Research Center have operated a 16-site parallel high volume air sampling network with glass fiber filters on one unit and Whatman-41 filters on the other. The network data and data from several other experiments indicate that (1) sampler-to-sampler and filter-to-filter variabilities are small, (2) hygroscopic affinity of Whatman-41 filters need not introduce errors, and (3) suspended particulate samples from glass fiber filters averaged slightly, but not statistically significantly, higher than from Whatman-41 filters. The results obtained demonstrate the practicability of Whatman-41 filters for air quality monitoring and elemental analysis.

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SUMMARY

The Air Pollution Control Division (APCD) of Cleveland, Ohio, and the NASA Lewis Research Center jointly operate a 16-site parallel high volume air sampling network. At each site one unit is operated with glass fiber filters to obtain total suspended particulate measurements for APCD, while the other unit is operated with Whatman-41 filters to provide particulate samples suitable for elemental and chemical analyses by Lewis. On the basis of data collected from the parallel network over a 13-month interval and some subsidiary experiments, various aspects of network sampling and filter properties have been studied. It was found that sampler-to-sampler and filter-to-filter variability introduce only small errors. The variability of the total suspended particulate measurements appear to be proportional to their absolute concentrations. The hygroscopic affinity of Whatman-41 filters does not introduce any error provided there is adequate equilibration and use of control blanks. From the paired network observations we find that the total suspended particulate samples collected with glass fiber filters were on the average slightly higher than those collected with Whatman-41 filters. At ten of the fourteen stations there was no statistically significant difference. Of the remaining four stations, there were three where the particulate matter on the glass fiber filters was higher (one much so), while one had the particulate matter on the Whatman-41 filter larger. We conclude that, over the network, there is no statistically significant difference. For environments similar to that of Cleveland, this study demonstrates the validity and practicability of using Whatman-41 filters in routine air quality monitoring programs to obtain samples suitable for elemental and chemical analyses.

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INTRODUCTION

In response to a request from the Air Pollution Control Division (APCD) of the City of Cleveland, Ohio, to NASA Lewis Research Center, the latter organization has undertaken a comprehensive investigation of trace elements and compounds in the urban air. The extent of the monitoring program of APCD and the scope of the Lewis effort have been presented elsewhere (refs. 1 and 2). As part of this program, the two agencies operate a 16-site parallel high volume air sampling network. At each site and for each 24-hour sampling period, one unit is operated with glass fiber filters to obtain total suspended particulate (TSP) measurements for APCD. The other unit at each site is operated with Whatman-41 (high purity, analytical, cellulose) filters to provide TSP samples suitable for elemental and chemical analyses by Lewis. This report considers the comparability of TSP data obtained from the two components of this network.

The Federal Environmental Protection Agency (EPA) mandated TSP collection technique for legal monitoring and control purposes requires the use of a high volume air sampler with the collection on 20.3 by 25.4 centimeter sheets (400 sq cm active region) of filter paper with a total air flow rate of 1.18 to 1.53 cubic meters per minute (ref. 3). Thus, high volume sampling is a basic tool in air quality monitoring, even though it is approximate and semi-quantitative (refs. 3 and 4). When operated on a judicious schedule, a high volume air sampler will yield data which can be used to evaluate such things as compliance with established standards, long-term trends, and the efficacy of various control strategies (ref. 5). (The sampling schedule recommended by EPA is a minimum of 61 random samples per year or its equivalent, ref. 6.) In this application, glass fiber filter media produce adequate samples with a minimum of procedural complications and have become the norm (ref. 3). As such, the glass fiber filters have been used by APCD since the inception of their monitoring program in 1967.

Another major application of high volume air sampling is to trap particulates which can then be analyzed for their element and compound content (ref. 6). Without extraction, the glass fiber filters are generally unacceptable for analytical work because of interference from the high concentrations of various elements in the filter itself (e.g., Na, when neutron activation analysis is attempted). Clearly, the inconvenience and, at times, inadequacy of chemical extraction procedures associated with glass fiber filters (refs. 7 and 8) makes a highly pure analytical type desirable for this application.

The major objective of this report is to determine the feasibility of using the Whatman-41 filter media on a routine TSP (high volume air) monitoring network. To this end we will ascertain both the relation between TSP collected on glass fiber filter and TSP collected on Whatman-41 filter measurements and the relative accuracy and precision of such data when accumulated from a sampling network spread out over a geographic region with varying TSP environments.

The first step is to determine the sources and extent of error variability. For example, to determine the differences between measurements due to using different high volume samplers, or the inherent variability of the filters of a given type. It will be shown in the former case that there is a small high volume sampler to high volume sampler variability. In the latter case, the variability within each of the two filter types will be shown to be essentially the same. Analyses were performed first assuming additive errors and then assuming that the errors are multiplicative with the implication that it is preferable to use the logarithms of the TSP values in the analyses.

On the basis of the network data it will be shown that the Whatman-41 filter and glass fiber filter measurements are closely related linearly and that the slope of the best-fitting straight line is very close to 1.0. This indicates that, compared to the other errors and for the Cleveland environment, the Whatman-41 and glass fiber filters are interchangeable.

Finally, it was found that the increase in variability of measurements taken in the network as opposed to measurements taken in close proximity and over a relatively small time interval is moderate.

HIGH VOLUME SAMPLING PROCEDURES

The 16-site APCD-Lewis monitoring network is shown in figure 1. At each site there are two high volume samplers spaced 2 to 3 meters apart. The operational procedures for both samplers are essentially equivalent to the EPA mandated procedures (ref. 3) except as now noted. The glass fiber filters used on the APCD samplers were MSA 1106B (Mine Safety Appliance Co., Pittsburgh, Pa.). They were mounted using a sponge rubber faceplate gasket and operated at a flow rate of 1.85 cubic meters per minute (60 ft^3/min). Upon removal, each filter was folded lengthwise and placed in a manila envelope. The Lewis samplers used Whatman-41 filters mounted in special cassettes as described in reference 9. The airflow was initially set at 1.1 cubic meters per minute (40 ft^3/min) and dropped to as low as half this rate by the end of the 24-hour sampling period as indicated by continuous flow recording. At these flow rates, the glass fiber filter is better than 99 percent efficient for a 0.3 micrometer aerosol using the dioctyl phthalate (DOP) smoke penetration test (ref. 10).

For larger aerosols ($\gtrsim 2\ \mu m$), the Whatman-41 filter is also better than 99 percent efficient (ref. 11). There are studies showing that as the aerosol size decreases to submicron size, the Whatman-41 filter collection efficiency is degraded to as low as 70 to 85 percent at the flow rates used in the Lewis samplers (refs. 11 to 14). However, it should be noted that DOP and other similar procedures are severe tests designed to rate absolute filters under laboratory conditions over very limited time intervals. As such,

they are not directly applicable to evaluating a filter collecting a large range of particle sizes in a relatively polluted environment. Of greater significance is the actual 24-hour field test which compared Whatman-41 filters to very efficient (>99 percent) polystyrene filters (ref. 15). Here, the conclusion was that little or no difference could be seen in collection efficiency. Presumably this is a consequence of the rapid plugging of the Whatman-41 filter air passages by the particles being collected. This phenomenon in one study (ref. 13), for a 0.365-micrometer aerosol collected at a low flow rate of 0.28 cubic meter per minute and a concentration of 500 micrograms per cubic meter, showed collection efficiency rising from an initial value of 75 percent to over 95 percent in less than 30 minutes.

PROCEDURES FOR HANDLING WHATMAN-41 FILTERS

Laboratory Procedures

Since glass fiber filters are essentially unaffected by relative humidities of up to 60 percent and the TSP collected is essentially unaffected by relative humidities of up to 50 percent (ref. 16), the glass fiber filters are equilibrated before weighing at 50 percent or less relative humidity for at least 24 hours and no humidity corrections are made.

Because the Whatman-41 filter has a tendency to sorb water and also because of the analytical work to be performed on samples collected on Whatman-41 filters, proper procedures must be followed or else erroneous TSP measurements will result. Thus, a description and a validation of the laboratory procedures for handling the Whatman-41 filters are in order.

A batch of filters (one for each station and three extra for controls) are removed from one package of Whatman-41 filters. These are all equilibrated at less than 50 percent relative humidity for at least 24 hours and then weighed. All but three of them are placed into cassettes for use in the field. After use in the field, the exposed Whatman-41 filters and the three unexposed Whatman-41 filters are again equilibrated at less than 50 percent relative humidity for more than 24 hours and then reweighed. The average change in weight of the three unexposed filters is algebraically subtracted from the change in weight of each of the exposed filters. The resulting corrected weight changes are herein identified as TSP-W41.

To validate this procedure an experiment was run in a clean room at Lewis. Six Whatman-41 filters were weighed on six different days with the relative humidity varying from 35 to 55 percent and the temperature nearly constant at 20° C. Figure 2 shows these weights plotted as a function of relative humidity. The close agreement to a linear weight increase with a uniform vertical shift among filters of different weights is obvi-

ous. From this we conclude that the humidity corrections do not vary from filter to filter, and, the use of control blanks is adequate to correct for water sorbtion. Due to the extreme sensitivity of elemental analyses (e.g., neutron activation and X-ray fluorescence), it is essential that the filters not be contaminated by contact with bare hands. Therefore, all handling of the Whatman-41 filters is done with rubber or plastic gloves.

Field Handling Procedures

After taring, the numbered Whatman-41 filters are loaded into cassettes which are labeled with a station name. A cover plate, with an attached air flow chart bearing the filter number, is placed on the cassette. Thus, in the field it is the cassette rather than the Whatman-41 filter that is handled. At the designated station the field service man transfers the cover plate and exchanges cassettes and flow charts. The flow rate is set to 1.1 cubic meters per minute (40 ft^3/min) and a timer is activated for the next scheduled 24-hour sampling period. The used cassette with its attached flow chart is returned to the laboratory for analysis.

At the laboratory the cassette is opened and the exposed filter with its TSP-W41 sample is removed, folded longitudinally, and placed in a rack for equilibration. The flow rate is read from the flow chart for each 3-hour interval from startup to shutdown. The air flow rate is determined by averaging these nine readings. The volume of air and the particulate concentration are calculated in the usual manner (ref. 3).

FACTORIAL EXPERIMENTS

Experiment Purpose and Description

If a Whatman-41 filter is a suitable substitute for a glass fiber filter for making TSP measurements, then it must yield approximately the same TSP values and its precision of measurement should be at least as good. Because factorial experiments would permit a comparison of the variability among measurements due to the use of different filter specimens (a measure of precision) within each filter type, two such experiments were performed at Lewis. The results were analyzed by the technique of analysis of variance (ANOVA) which is described in a number of standard texts on experimental design and analysis (refs. 17 and 18).

In the first experiment, five high volume samplers were run simultaneously at one location with glass fiber filters for nine different 24-hour periods. The data from the fifth sampler was discarded from this analysis because of a gasket leak which was de-

tected part way through the experiment. The measurements in micrograms per cubic meter are given in table I. In the second experiment, the same five high volume samplers were operated simultaneously at the same location for four different 24-hour periods using Whatman-41 filters. The resulting TSP measurements in micrograms per cubic meter are presented in table II.

For each of these experiments, the data are tabulated in a two-way table where the column headings are the sampler number and the row headings are the dates of operation. Because of the two-way nature of the data it is possible, using the appropriate statistical model, to separately estimate (1) the variability among measurements due to the use of different samplers, (2) the variability among measurements due to the measurements being taken on different days (i.e., possibly measuring different TSP environments), and (3) the variability among measurements due to all other sources including the use of different filter specimens. The ANOVA technique is dependent on a model equation for the data. Because of the lack of definitive evidence to determine a unique model equation, two plausible forms are presented here.

Additive Model

The first model assumes that a value of TSP obtained on day i from sampler j can be written as

$$g_{ij} = \mu_g + d_i + s_j + \epsilon_{ij}$$

$$w_{ij} = \mu_w + d_i + s_j + \delta_{ij}$$

for TSP-GF and TSP-W41, respectively. The term μ represents a mean overall TSP level, d_i a deviation from the overall mean due to day i, and s_j the deviation from the overall mean due to the observation being taken from sampler j. Thus, it is assumed that each of the sources of variability is completely additive in nature and that there is no interaction between the day effect and sampler effect. For example, if sampler j tends to measure a higher value than average on day i, then it tends to measure the same amount higher than average on day i'.

The ϵ_{ij} and δ_{ij} represent random errors of observation from all other sources including those due to the random variations among the actual filter specimens. In statistical terminology these might be called the within-filter-type errors for glass fiber and Whatman-41 filters.

Multiplicative Model

Since 24-hour averaged TSP sampling is a cumulative procedure, it seems reasonable to assume that errors are also cumulative in nature. Data in favor of multiplicative errors have been noted in two recent studies of high volume sampling reproducibility (refs. 19 and 20).

Because of the preceding considerations, it is reasonable to assume that the random errors ϵ_{ij} and δ_{ij} may be multiplicative in nature rather than additive. If so, the logarithms of the TSP values are assumed to be normally distributed, in which case it is more appropriate to use the model equations

$$\left.\begin{aligned} g_{ij}^* &= \mu_g + d_i + s_j + \epsilon_{ij} \\ w_{ij}^* &= \mu_w + d_i + s_j + \delta_{ij} \end{aligned}\right\} \text{equivalently} \left\{\begin{aligned} g_{ij} &= 10^{\mu_g + d_i + s_j + \epsilon_{ij}} \\ w_{ij} &= 10^{\mu_w + d_i + s_j + \delta_{ij}} \end{aligned}\right.$$

where

$$g_{ij}^* = \log\,(g_{ij})$$

$$w_{ij}^* = \log\,(w_{ij})$$

and μ_g, μ_w, d_i, s_j, ϵ_{ij}, and δ_{ij} are quantities associated with the same sources as they were in the additive model.

Analysis

In the previous models it is assumed that

$$\epsilon_{ij} \sim N\left(0, \sigma_g^2\right)$$

$$\delta_{ij} \sim N\left(0, \sigma_w^2\right)$$

$$s_j \sim N\left(0, \sigma_s^2\right)$$

and that all are mutually independent random variables where $x \sim N(0, \sigma^2)$ denotes that the random variable x follows a normal distribution with mean zero and variance σ^2.

In terms of the notation introduced, we want to do the following. First, we want to estimate the variability attributable to sampler differences ($\hat{\sigma}_s^2$) and the within-filter-type variability when using glass fiber filters ($\hat{\sigma}_g^2$) and Whatman-41 filters ($\hat{\sigma}_w^2$). (The symbol ˆ indicates an estimate of the quantity.) Next, we want to decide if σ_s^2 is significantly larger than either σ_g^2 or σ_w^2. This would tell us whether there is evidence of high volume differences or if high volume variability is simply a reflection of error variability. Finally, since σ_g^2 and σ_w^2 include filter variability, we also want to determine if $\sigma_w^2 \leq \sigma_g^2$.

The data of tables I and II were analyzed using ANOVA, and the resulting ANOVA tables are presented in table III. As mentioned previously, the technique of ANOVA permits the total variability of the observations to be partitioned into variability due to different factors. The first column identifies the factor or source of variability. The next three columns give the sums of squares (SSQ), degrees of freedom (df), and the mean squares (MS) for each of these sources. The last column provides in symbols what the expected values of the mean squares are for each source. From table III(a) σ_w^2 may be estimated by $\hat{\sigma}_w^2 = 7.87$. Also, it may be noted that the ratio of MS(s) over MS(δ) can be used to indicate whether MS(s) is significantly larger than the MS(δ). Under the previously made assumptions and under the hypothesis that $\sigma_s^2 = 0$, this ratio is known to follow an F-distribution with 4 and 12 degrees of freedom. Thus, the computed $F = 22.90/7.87 = 2.91$ may be compared to the tabulated values (ref. 17) to test if σ_s^2 is significantly larger than zero. Similar comments apply to tables III(b) to (d).

Comparing the computed F-ratio for both the glass fiber and Whatman-41 data with tabulated F values (ref. 17) shows that the sampler-to-sampler variability is significantly larger (at significance levels of 0.10 for Whatman-41 and 0.01 for glass fiber) than the error variability. From this it can be concluded that there do exist systematic sampler-to-sampler differences.

The means of the raw TSP values and also the means of the logs of the TSP values for each sampler are listed at the bottoms of the appropriate columns in tables I and II. It is noted that in the glass fiber experiment the order from smallest to largest is exactly opposite to the order in the Whatman-41 experiment. While we know of no reason for this exact reversal, it is possible that it was a chance happening resulting from our operational procedure which set the flow for each sampler at the beginning of each of the experiments and subsequently recorded the flow rates each day without any resetting of flows. If the differences from sampler to sampler are indeed due to flow rate errors, they would presumably be of a multiplicative nature, which lends further credibility to the use of the logarithms of the TSP values.

The error variances σ_g^2 and σ_w^2 are now considered. It is well known (refs. 17 and 18) that the respective mean square errors (lower right corners of table III) are unbiased estimates of σ_g^2 and σ_w^2. Thus, for the data in its original form,

$$F = \frac{\hat{\sigma}_w^2}{\hat{\sigma}_g^2} = \frac{7.87}{9.76} = 0.806$$

and for the logarithmically transformed data,

$$F = \frac{\hat{\sigma}_w^2}{\hat{\sigma}_g^2} = \frac{0.000453}{0.000429} = 1.056$$

Neither of these ratios differs significantly from unity. While this does not prove that the two error variances are actually the same, it does lend credence to such an assumption, and we therefore do assume $\sigma_g^2 = \sigma_w^2$.

As an unbiased estimate of σ_s^2 we use

$$\hat{\sigma}_s^2 = \frac{\text{MS(s) - MS(error)}}{\text{number of days}}$$

Unlike the previous cases ($\hat{\sigma}_g^2$ and $\hat{\sigma}_w^2$) the two estimates of σ_s^2 cannot be compared by an F-ratio.

If $\sigma_g^2 = \sigma_w^2$ is assumed and since the estimates from the two experiments are independent, a pooled estimate may be computed as

$$\hat{\sigma}^2 = \frac{SSQ(\epsilon) + SSQ(\delta)}{df(\epsilon) + df(\delta)}$$

To obtain an estimate of the total variability σ_t^2 of a measurement made on a given day on an unspecified sampler we use the following ad hoc equation:

$$\hat{\sigma}_t^2 = \hat{\sigma}^2 + \frac{\hat{\sigma}_{s(GF)}^2 + \hat{\sigma}_{s(W41)}^2}{2}$$

These respective estimates are all tabulated in table IV for the data in both the original and the log transformed forms.

The interpretation of these estimates is as follows. From the raw TSP values, $\hat{\sigma} = 3.02$ is obtained. This is the estimated standard deviation of the errors attributable to within-filter-type differences and hence is an upper bound on filter-to-filter variability. From the assumption of normally distributed errors, it is estimated that approx-

imately 95 percent of these errors are within ±6.04 micrograms per cubic meter. Since the overall TSP values are about 60 micrograms per cubic meter, this corresponds to about a 10 percent error limit. The estimates of $\hat{\sigma}_s$ are both about 2.0 and imply that about 95 percent of the errors due to high volume variability are within 4.0 micrograms per cubic meter. The estimate $\hat{\sigma}_t = 3.61$ implies that on any given day about 95 percent of the total error components (includes high volume variability filter, variability, and all other sources) are within ±7.2 micrograms per cubic meter. This is about 12 percent of the mean of the observed TSP values.

The interpretation of the estimates using the log-transformed data is similar. The estimate $\hat{\sigma} = 0.0209$ implies that 95 percent of the within-filter-type errors, including filter differences, are within ±0.042. This describes the differences in terms of logs. In terms of raw values, this implies that about 95 percent of the errors lead to values within factors of $10^{-0.042}$ and $10^{0.042}$. These values are 0.91 and 1.10. Thus, only about 5 percent of the errors cause values more than 10 percent higher or 9 percent lower than the actual value. Similarly, the values for $\hat{\sigma}_s$ averaged to 0.0148 and imply 95 percent proportionality factors of 0.93 and 1.07. The estimate $\hat{\sigma}_t = 0.0256$ implies 95 percent proportionality factors of 0.89 and 1.12.

The percentage limits on variability are seen to be comparable from the analyses using actual TSP values and log-transformed data.

Conclusions

The conclusions drawn from these two experiments are as follows: First, there is a statistically significant variability among the responses from several high volume samplers run at the same location on the same day. The magnitude of this variability is relatively small (95 percent limits of about 7 percent) with a possible contributing factor being variability in the sampler flow rates. Second, the variability among measurements within any particular high volume sample (which is assumed to be mainly attributable to filter differences) is also small (95 percent limits of not more than 10 percent). Third, the error variabilities of the Whatman-41 and glass fiber filter types are found to be almost identical and clearly not statistically significantly different.

PARALLEL NETWORK

Experiment Purpose and Description

The previous section presented an analysis that indicated that both glass fiber and Whatman-41 filters have essentially the same precision of measurement. We next want

to determine if the two filter types yield the same TSP measurements and, if not, is there some relation between the two measurements.

At the 16 APCD-Lewis monitoring sites there are two high volume air samplers spaced 2 to 3 meters apart. One sampler operates only with glass fiber filters and collects TSP data for analysis by APCD. The other sampler operates only with Whatman-41 filters and collects TSP data for elemental analysis by Lewis. The Lewis high volume samplers were modified to accept cassette filter holders, which had been designed to minimize handling the Whatman-41 filters. Since this modification was not made to the APCD samplers, an interchange of filter types between the APCD and Lewis samplers was not possible.

The data used in this study are derived from the paired measurements taken at the 16 network sites over a period of 13 months. For a variety of reasons, not related to the filter media, some runs did not yield TSP measurements for both glass fiber and Whatman-41 filters. Only where both a glass fiber and a Whatman-41 value were observed for the same 24-hour period are values recorded in table V. The number of paired values observed varies from 48 at station 13 to 91 at station 3. Preliminary analyses indicated that the data from stations 4, 9, and 13 were suspect. Further investigation confirmed operational irregularities for stations 9 and 13 and these have thus not been included in the analyses. An examination of the data log book showed that the Whatman-41 sampler at station 9 was blown over in a high wind on December 11, 1971. It was then righted and put back into use by the field man without recalibration or other checking. Examination of the raw data shows that prior to this date, the TSP Whatman-41 and TSP glass fiber values are comparable in magnitude. After this date it is seen that the TSP glass fiber values are about twice as large as the TSP Whatman-41 values. Station 13 is the only ground-level high volume sampler site, and it was plagued by intermittent vandalism which rendered the data unreliable. A significant amount of construction took place in the vicinity of station 4. However, we cannot substantiate any conjecture as to what effect this might have had on the high volume sampling.

As with the ANOVA analysis, we proceed with two models assuming in one that the errors of observation are additive and in the other that the errors are multiplicative. Again, both models lead to essentially the same conclusions.

Additive Model

For this model where the errors are assumed to be additive, we estimate a best-fitting straight line to the data of the form

$$G = \alpha + \beta W \tag{1}$$

where G is the mean TSP glass fiber value and W the mean TSP Whatman-41 value on a given day. Since we assume that when there is a zero TSP level both G and W must be zero, we also estimate a best-fitting straight line where α is constrained to be zero. Both estimating lines were computed because there are very few observed TSP levels below 40 and none close to zero and we wished to allow for any relation between G and W which might be approximated throughout the range of observations by a linear relation. It will be seen, however, that in almost all cases the two estimating lines are quite close together.

The first calculational procedure used was plotting TSP Whatman-41 values against TSP glass fiber values. We feel that the plotting and line fitting should be done separately for each station. First, there are sampler-to-sampler biases as was established in a previous section. Second, there exists the possibility that the local climatology, particle size distributions, and so forth, will vary from station to station and that these variables may affect the TSP collection process. Therefore, plots of TSP glass fiber against TSP Whatman-41 at each of the 16 reporting stations are presented in figure 3. These plots also include the two best-fitting straight lines.

The appropriate statistical method to derive the best-fitting straight lines is well described in the literature (refs. 18 and 21). This approach differs from that used in earlier studies (refs. 20 and 22) of network monitoring results. The differences between these methods are considered further in the DISCUSSION section.

The details of the development of the statistical model used in this analysis are as follows for any single specified sampling station:

P_i	actual mean ambient TSP level over 24-hour sampling period i
$G_i = p_g(P_i + S_g)$	population mean amount of TSP which would be collected on glass fiber filters in sampling period i using glass fiber sampler with bias S_g; p_g, collection efficiency
$W_i = p_w(P_i + S_w)$	population mean amount of TSP which would be collected on Whatman-41 filters in sampling period i using Whatman-41 sampler with bias S_w; p_w, collection efficiency

Thus, on ideal unbiased samplers,

$$G_i = p_g P_i$$

$$W_i = p_w P_i$$

It is assumed that the actual measured amounts of TSP collected on glass fiber and Whatman-41 filters, respectively, are given by

$$\left.\begin{aligned} g_i &= G_i + \epsilon_i \\ w_i &= W_i + \delta_i \end{aligned}\right\} \tag{2}$$

where ϵ_i and δ_i are the random errors of observations. (All symbols are defined in appendix A.) It is assumed that ϵ_i and δ_i are all independently distributed as $N(0, \sigma^2)$. (We assume the same variance for both errors because of the results obtained from the factorial experiments discussed previously.)

From the relation

$$W_i = p_w(P_i + S_w)$$

we get

$$P_i = \frac{W_i}{p_w} - S_w$$

and, hence,

$$\begin{aligned} G_i &= p_g(P_i + S_g) \\ &= p_g\left(\frac{W_i}{p_w} - S_w + S_g\right) \\ &= \frac{p_g}{p_w} W_i + p_g(S_g - S_w) \\ &= \beta W_i + \alpha \end{aligned} \tag{3}$$

We assume the collection efficiencies are unaffected by particle size. This is probably not quite true, but we feel it should not seriously affect the conclusions. In this form it can be seen that the slope of the best-fitting straight line of equation (3) is an estimate of p_g/p_w, which is the relative collection efficiency of glass fiber as compared to Whatman-41. The quantity α is a measure of the combined effects of sampler bias and any constant differences between filter types. Since we might assume that when $P_i = 0$ both W_i and G_i equal zero, a best-fitting straight line subject to the constraint $\alpha = 0$

is also estimated. That is, the estimating line is required to pass through the origin. The model with α arbitrary is referred to as model I and the model with $\alpha = 0$ is referred to as model II.

For model I, Kendall and Stuart (ref. 21, chap. 29) describe estimators for α, β, and σ^2. These are also given in appendix B. For this model it is also possible to test if the obtained estimate $\hat{\beta}$ of β is significantly different than some prescribed value. In this problem we hoped that $\beta = 1$ and are interested in whether or not $\hat{\beta}$ is much different from 1. The test of β depends on a statistic which follows a student's t-distribution with (n - 2) degrees of freedom. The formula for computing the t-value is also presented in appendix B.

For model II, the estimators for β and σ^2 are also described in appendix B. For this model, however, there are no known methods for making significance tests about β.

Figure 3 presents plots of the actual data points and the two best-fitting straight lines for each station. Except for stations 4 and 13, the two lines are almost indistinguishable. The estimated coefficients for each model are given at the bottom of each section of table V. Because the two lines are so close together in most cases, the remaining discussion is restricted to model I since it provides the capability of testing $\hat{\beta}$. In table VI the estimates $\hat{\alpha}$ and $\hat{\beta}$ and the t-statistic for each station are summarized.

Several facts may be noted from table VI. First, except for stations 4, 9, and 13, all the $\hat{\beta}$ values are quite close to 1.0 with six of the estimates above 1.0 and seven below. Reasons for rejecting data from stations 9 and 13 were presented previously. Station 4 calls attention to itself because its $\hat{\beta}$ of 0.534 is so far removed from the other values. There was, however, no independent indication of equipment or procedural malfunction, nor does examination of the original data indicate any suspicious pattern. (During the sampling period some heavy construction took place in the near neighborhood. This is mentioned although it would be unsupported speculation to assume that this might have disturbed the measurements.)

If the previously mentioned three stations are excluded, it is found that the average $\hat{\alpha}$ value is 5.21 and the average $\hat{\beta}$ value is 1.023. Of the thirteen stations, four of the β values are significantly different from 1.0 at the 5 percent significance level as indicated by the t-statistics. Three of these are significantly greater than 1.0 while the other is significantly smaller than 1.0. We conclude from these results that the parameter values $\alpha = 0.0$ and $\beta = 1.0$ are an adequate overall representation.

Multiplicative Model

In this model we also make the simplifying assumption that the respective efficiencies are unaffected by particle size, etc.. This assumption should not seriously affect

the conclusions. At any single station let P_i denote the actual mean of the logarithm of the ambient TSP level on day i. Let G_i and W_i denote the population mean amounts of TSP which would be collected on glass fiber and Whatman-41 filters, respectively, on day i where s_g and s_w are the logarithms of the sampler biases. The efficiency factors are p_g and p_w, respectively. It is assumed

$$W_i = \exp_{10}\left[p_w(P_i) + s_w\right]$$

$$G_i = \exp_{10}\left[p_g(P_i) + s_g\right]$$

Let w_i and g_i denote the actual sampled Whatman-41 and glass fiber values, respectively, on day i. It is assumed

$$w_i = W_i \, 10^{\delta_i} \tag{4a}$$

$$g_i = G_i \, 10^{\epsilon_i} \tag{4b}$$

where ϵ_i and δ_i are random errors of observation. It is also assumed that $\epsilon_i \sim N(0, \sigma^2)$ and $\delta_i \sim N(0, \sigma^2)$ with all the ϵ_i and δ_i mutually independent. Thus,

$$w_i^* = \log w_i = p_w P_i + s_w + \delta_i \tag{5a}$$

$$g_i^* = \log g_i = p_g P_i + s_g = \epsilon_i \tag{5b}$$

Let

$$m_i = \log\left(\frac{g_i}{w_i}\right) = \log g_i - \log w_i$$

$$= (p_g - p_w)P_i + (s_g - s_w) + (\epsilon_i - \delta_i) \tag{6}$$

and if there are n pairs of observations, let

$$\overline{m} = \sum \frac{m_i}{n}$$

In terms of this notation, a test of equality of filter efficiencies is a test of equality of p_g and p_w. Under the assumptions the expected value of $\overline{m}$ at a particular station, using the given two samplers, is

$$E(\overline{m}) = s_g - s_w + (p_g - p_w)E(P_i) \tag{7}$$

where $E(P_i)$ is the expected pollution level over all days at that station. Thus, when $p_g = p_w$ this reduces to

$$E(\overline{m}) = s_g - s_w$$

The variance of $\overline{m}$ at this station is

$$V(\overline{m}) = \frac{1}{n}\left[V(\epsilon) + V(\delta)\right]$$

$$= \frac{2\sigma^2}{n}$$

since s_g and s_w are constant at any specified station.

From the j^{th} station it is impossible to determine if $p_g = p_w$ since the mean difference involves the difference between samplers (eq. (7)). When comparing several stations, however, we can determine if $p_g - p_w = 0$. If we assume, as in the factorial experiments, that s_{gj} and s_{wj} are independently $\sim N(0, \sigma_s^2)$, then we see that taking expectations of $\overline{m}_j$ over all the possible samplers that could have been used at that station yields

$$E(\overline{m}_j) = (p_g - p_w)E(P_i)_j \tag{8}$$

$$V(\overline{m}_j) = 2\sigma_s^2 + \frac{2\sigma^2}{n_j}$$

and $\overline{m}_j$ is normally distributed. Averaging across stations thus averages the $s_g - s_w$ quantity, and the expectation of this average difference is zero. Since not all the stations have the same expected value or the same number of paired observations, the $\overline{m}_j$'s for each station are not identically distributed. However, the values of n_j obtained range from 48 to 91 and $2\sigma^2/n_j$ should be small compared to $2\sigma_s^2$. (See the

estimates for σ and σ_s from the factorial experiments.) Thus, it may be assumed that the $\overline{m}_j$'s are approximately normally distributed with the same standard deviation. If the hypothesis $p_g = p_w$ is true, then the means are zero; if the hypothesis is not true, then the means are not zero (eq. (8)).

Included in tables V to XX are the log (g_i), log (w_i), log (g_i) - log (w_i), and $\overline{m}_j$ values for each station. Table VII summarizes the $\overline{m}_j$ values. The sample cumulative distribution of the 14 $\overline{m}_j$ values (i.e., excluding stations 9 and 13) is presented in table VII and plotted on normal probability paper in figure 4. The probability plot indicates that the $\overline{m}_j$ values are close enough to a straight line to support saying that they are identically and independently normally distributed. In this case, an approximate t-test is used to determine if the mean of the $\overline{m}_j$ (denoted $\overline{\overline{m}}$) is significantly different than zero.

From these 14 stations,

$$\overline{\overline{m}} = \frac{\sum \overline{m}_j}{14} = 0.0204$$

and the sample standard deviation of the $\overline{m}$'s is

$$s_m = \sqrt{\frac{\sum (\overline{m}_j - \overline{\overline{m}})^2}{13}} = 0.0511$$

Under the previously stated assumptions the quantity s_m^2 estimates $V(\overline{m}_j) \approx 2\sigma_s^2$, and hence $s_m/\sqrt{2} = 0.036$ is an estimate of σ_s. This compares moderately well with the values of 0.0143 and 0.0153 derived from the factorial experiments. The 0.036 value yields a 95 percent error band of ±0.072 in terms of the logs. In terms of the actual TSP values, the error of $10^{\pm 0.072}$ corresponds to proportionality factors of 0.85 and 1.18. That is, the error band due to sampler variability is about 18 percent high to 15 percent low. This compares with 95 percent error limits of about ±7 percent from the factorial experiments.

A 98 percent confidence interval on $\overline{\overline{m}}$ is given by

$$\overline{\overline{m}} \pm t_{13,\,0.99} \frac{s_m}{\sqrt{14}} = -0.0159,\ 0.0567$$

The mean value $\overline{\overline{m}} = 0.0204$ corresponds to a proportionality factor of $10^{0.0204} = 1.0481$. That is, data have been observed where the TSP glass fiber values average about 4.81 percent higher than the TSP Whatman-41 values. The confidence limits on $\overline{\overline{m}}$ give proportionality factors of 0.9641 and 1.139.

The t-statistic for testing the significance of the difference of $\overline{\overline{m}}$ from zero (i.e., two-sided test) is

$$t = \frac{\overline{\overline{m}}}{\frac{s_m}{\sqrt{14}}} = 1.50$$

and it is nonsignificant at the 10 percent significance level. Therefore, we conclude that $p_g = p_w$, which is to say that the difference between Whatman-41 efficiency and glass fiber efficiency is not statistically significant.

Distribution of Errors

As an aid to determining the distribution of the errors, the sample cumulative distributions of $(g_i - w_i)$ as well as those of $(\log(g_i) - \log(w_i))$ were plotted on a normal probability scale. It was seen by visual examination that the central portion of each plot was generally close to a straight line. It appeared that either the additive or the multiplicative model would be adequate. The full set of these 32 distributional plots is available on microfiche on request from the authors.

Conclusion

The previous analyses of the parallel network data show that after more than a full year of operation the evidence is inadequate to support a general claim that Whatman-41 filters are either more or less efficient than glass fiber filters. At any given station there may be a statistically significant difference between the average measurements of the Whatman-41 and glass fiber filters. Although this difference slightly favors higher glass fiber measurements, this difference is just about as likely to have the glass fiber filters yield higher TSP values than the Whatman-41 filters as to have the Whatman-41 filters yield higher TSP values than the glass fiber filters. It is quite likely that such local effects as micrometeorology, particle size distributions, relative placement of the samplers on roof tops, biases due to calibration errors, or other sampler biases may

be of importance in explaining the observed differences between Whatman-41 and glass fiber filter types.

DISCUSSION

In this section, we first consider in more detail the relation of the work reported herein with pertinent aspects of three studies referenced earlier concerning the reproducibility of high volume sampling. We then consider the implications of these findings for routine ambient air monitoring.

Factorial Experiments

There have been two recently reported studies comparable to the factorial experiments reported herein. Both of these concerned glass fiber data only. One involved 4 adjacent high volume air samplers operated on 20 sampling days (ref. 20) and the other involved 12 adjacent high volume air samplers operated on 4 sampling days (ref. 19). In general, there is good overall qualitative agreement with our results despite some quantitative differences. The major quantitative difference indicates that there is slightly more variability in glass fiber data reported herein than in either of the other experiments. For instance, what we call within filter type variability with a standard deviation of 5 percent corresponds to the single analyst variation with a 3 percent standard deviation reported by McKee et al.. Similarly, Clements et al. report that 50 percent of their paired values differ from the "true" value (i.e., mean of the pair) by less than ±2.5 and 90 percent by less than ±6.5 percent. The application of their analytic techniques to the data reported herein gives ±3.0 and ±7.5 percent, respectively.

Despite these differences the work reported herein confirms the earlier findings that the measured TSP values are adequately reproducible. Like Clements et al., we believe that air flow calibration may be a major component of error and that the error term should be expected to enter multiplicatively rather than additively.

As noted previously, both the other studies were restricted to glass fiber filters, whereas the factorial experiment reported herein was performed twice - once with glass fiber filters and once with Whatman-41 filters and obtained similar results in each instance.

Network Experiments

There are two recent network studies involving paired high volume samplers. Again, both reports are concerned with glass fiber filters only. One report on 25 sites operated for 10 sampling days (239 paired samples) (ref. 20) and the other reports on 4 sites operated daily over a 5-month period (430 paired samples) (ref. 22). In both of these studies the reported results are for all the data considered as a single set and effectively analyzed under the assumption $\alpha = 0$, $\beta = 1$ (this is implicit in measuring all deviations relative to the mean of each pair). From the viewpoint of the network operator these are obviously the most desirable values of α and β. The referenced studies indicate that this model quite adequately represents the data; that is, high volume sampling with a glass fiber media is reproducible.

In the network study reported herein, advantage was taken of the large number of paired results to evaluate the features of the data set for each site separately. For the comparison of glass fiber filters with Whatman-41 filters, a best-fitting line was determined by calculating α and β for each site.

Just as in our factorial experiments, our network experiments show greater variability in comparison with other network studies. Typical of the difference is the following. When measured from the $\alpha = 0$, $\beta = 1$ line, Lee et al. found 95 percent of the sample pairs within ±10 percent and Clements et al. found 95 percent within ±16 percent (their fig. 3). Our analysis relative to the differences of the pairs of logarithms of the values gives 95 percent within +18 to -15 percent (the asymmetry arises from the assumption of log normality). The distribution of best-fitting lines for relating glass fiber and Whatman-41 filters has an average slope, $\beta = 1.023$, and an ordinate intercept of $\alpha = 5.2$ where the overall mean of all the data at the 13 stations considered is 131.0. It is concluded that even though there are station-by-station differences the results presented in the previous section indicate that $\alpha = 0$, $\beta = 1$ is an adequate overall representation.

Since both factorial experiments showed similarly greater variability than reported by other experimenters, it is not felt that our higher network variability can be attributed to the introduction of a second filtering media. One explanation for which supporting evidence is lacking at present would be to ascribe this variability to the heterogenity of the dispersion of suspended particulates from station to station in the Cleveland area.

In the network study these conclusions not only imply reproducibility of high volume sampling but also carry the further implication that Whatman-41 filters may be used in place of glass fiber filters for high volume monitoring in environments similar to that found in Cleveland.

Sampling Objectives

In the introductory remarks we noted two primary motivations for high volume sampling. One is to obtain samples of suspended particulate matter for elemental, chemical, and/or physical analyses. The other is to establish gross TSP concentrations on a weight basis as part of a legal program to identify and abate particulate pollution. For the former, the advantages of using a high purity filter media are evident. The major contribution of this study to such a program would be to give added credibility to absolute measurements taken on the Whatman-41 filter where in the past some researches have felt that only relative measurements were reliable (ref. 23). For the latter, however, despite some known exceptions, there has been a general hesitancy to monitor routinely with Whatman-41 filters presumably as a consequence of the explicit preference given to glass fiber filters by EPA (ref. 3). In this regard some observations will follow.

The Federal requirement for TSP high volume monitoring can be satisfied by taking 61 random samplings per year. From this sample set one has to determine compliance with various standards. The national primary ambient air quality standards for particulate matter require the following:

(1) 75 micrograms per cubic meter - annual geometric mean

(2) 260 micrograms per cubic meter - maximum 24-hour concentration not to be exceeded more than once per year

The national secondary ambient air quality standards for particulate matter require the following:

(1) 60 micrograms per cubic meter - annual geometric mean

(2) 150 micrograms per cubic meter - maximum 24-hour concentration not to be exceeded more than once per year

Such standards in effect require estimating the geometric mean and the next to the largest TSP level for the year. This is conceptually equivalent to evaluating the statistical distribution of the data and applying order statistics to the resulting distribution. In practice, EPA has suggested that the distribution be assumed log normal (ref. 5). Thus, there are three intrinsic sources of error in comparing measured values to legal standards - namely, the assumption of log normality and the two errors when estimating the mean and the next to the largest value for a set of 365 values represented by a sample of 61 values. It has been shown that for log normal distributions with typical standard geometric deviations (i.e., exponential of the standard deviation of the logarithms of the sampled values) of 1.5 to 1.85 (ref. 2) the 0.95 confidence limits for the mean based on 61 samples out of 365 values are ±10 and ±15 percent, respectively (refs. 24 and 25). The extrapolation to the extreme tail of the distribution to obtain the second highest value will have confidence limits at least as wide (ref. 26). There is no feeling for the

error involved in assuming log normality, but deviations from log normality for TSP data have been reported (ref. 2).

As a consequence of these factors, it is reasonable to conclude that reproducibility in high volume sampling is not the major source of errors in current monitoring practices. In addition, we have just shown that the data distributions obtained from glass fiber and Whatman-41 filters are usually not statistically significantly different. Even in those few cases which are significantly different (see table VI), the differences are generally within the error bounds inherent in evaluating compliance with presently formulated standards as explained previously.

CONCLUDING REMARKS

A comparative analysis of Whatman-41 and glass fiber filters based on data derived from three experiments has been presented.

The first experiment shows that if adequate precautions are taken, the hygroscopic affinity of Whatman-41 filters does not introduce any significant error in determining TSP concentrations.

The second was actually a sequence of two factorial experiments. In these, five samplers were run in close proximity over a relatively short interval of time. One experiment had the samplers equipped with glass fiber filters while the other had the samplers equipped with Whatman-41 filters. There are several conclusions drawn from these two experiments. First, there is a statistically significant variability among the responses from several high volume samplers run at the same location on the same day. The magnitude of this variability is relatively small (95 percent limits of about 7 percent), and we speculate that the cause of variability is the difficulty of determining the actual flow rates for all samplers. Second, the variability among measurements attributable to differences within each filter type is also small (95 percent limits of about 10 percent). Third, the error variabilities of the Whatman-41 and glass fiber filter types are found to be almost identical and clearly not statistically significantly different.

The third experiment was the 13 months of operation of a 16-station parallel network. At each of the 16 stations, two high volume air samplers were set up in close proximity where one (APCD sampler) was equipped with glass fiber filters and the other (Lewis sampler) was equipped with Whatman-41. The paired data values obtained over a 13-month interval were analyzed twice. Once with the assumption of additive errors and once with the assumption of multiplicative errors. Both analyses showed that at any given station there may be a significant difference between the two filter types. However, when the entire network is considered, this difference is concluded not to be

statistically significant. For environments similar to Cleveland's, this study demonstrates the validity and practicability of using Whatman-41 filters in routine air quality monitoring programs to obtain samples suitable for elemental and chemical analyses.

Lewis Research Center,
National Aeronautics and Space Administration,
Cleveland, Ohio, January 31, 1974,
770-18.

APPENDIX A

SYMBOLS

d	deviation from μ due to particular day
E(x)	expected value of x
F	statistic following F-distribution
G	population mean amount of TSP which would be collected on glass fiber filters, see also p. 12
g	TSP measured level collected on glass fiber filters
m	log (g/w)
$N(0, \sigma^2)$	normal distribution with mean zero and variance σ^2
P	actual mean ambient TSP level
p	collection efficiency
S_m	sample standard deviation of $\overline{m}$'s
s_g, s_w	sampler biases
V(x)	variance of x
v_g^2, v_w^2, v_{gw}	sample variances and covariance of glass fiber and Whatman-41 data
W	population mean amount of TSP which would be collected on Whatman-41 filters, see also p. 12
w	TSP measured level collected on Whatman-41 filters
$\overline{x}$	mean of x
$\hat{x}$	estimate of x
x^*	logarithm of x
α	intercept of best-fit straight line
β	slope of best-fit straight line
δ	random error due to Whatman-41 within-filter-type variation
ϵ	random error due to glass fiber within-filter-type variation
μ	mean TSP level
σ	standard deviation

Subscripts:

g glass fiber

i i^{th} day

j j^{th} sampler or j^{th} station

t total

w Whatman-41

m distribution of $\overline{m}$

APPENDIX B

ANALYSIS OF FUNCTIONAL RELATIONS

In this appendix some statistical methods for computing best-fitting straight lines to data where both variables have observational errors will be briefly presented.

The following mathematical structure was assumed for n observations:

$$g_i = G_i + \epsilon_i$$

$$w_i = W_i + \delta_i$$

$$G_i = \alpha + \beta W_i \qquad \text{(Model I)}$$

$$G_i = \beta W_i \qquad \text{(Model II)}$$

$$\left.\begin{aligned} \epsilon_i &\sim N(0, \lambda\sigma^2) \\ \delta_i &\sim N(0, \sigma^2) \end{aligned}\right\} \lambda \text{ assumed known}$$

For our application, λ was concluded to be 1.0 from the factorial experiment analyses.

Model I Estimation

For model I (eq. (3)) maximum likelihood estimation procedures lead to the following estimators (ref. 18, chapter 9, or ref. 21, sections 29.1 to 29.21):

$$\hat{\alpha} = \overline{g} - \hat{\beta}\overline{w}$$

$$\hat{\beta} = \frac{\left(v_g^2 - \lambda v_w^2\right) + \left[\left(v_g^2 - \lambda v_w^2\right)^2 + 4\lambda v_{wg}^2\right]^{1/2}}{2v_{wg}}$$

where

$$\bar{g} = \frac{\sum g_i}{n}$$

$$\bar{w} = \frac{\sum w_i}{n}$$

$$v_g^2 = \frac{\sum (g_i - \bar{g})^2}{n}$$

$$v_w^2 = \frac{\sum (w_i - \bar{w})^2}{n}$$

$$v_{gw} = \frac{\sum (g_i - \bar{g})(w_i - \bar{w})}{n}$$

and the consistent estimator for σ^2 is

$$\hat{\sigma}^2 = \frac{\lambda}{(n - 2)(\lambda + \hat{\beta}^2)} \sum (g_i - \hat{\alpha} - \hat{\beta} w_i)^2$$

Model II Estimation

For this model the method of maximum likelihood was applied and the procedure was similar to Kendall and Stuart. The likelihood function is (similar to eq. 9.1 of ref. 18)

$$L = \frac{1}{(\lambda\sigma^2 2\pi)^{n/2}} e^{-1/2 \sum \frac{\epsilon_i^2}{\lambda\sigma^2}} \frac{1}{(\sigma^2 2\pi)^{n/2}} e^{-1/2 \sum \frac{\delta_i^2}{\sigma^2}}$$

$$= (\lambda^{1/2}\sigma^2 2\pi)^{-n} \exp -\frac{1}{2} \left[\frac{\sum (g_i - \beta W_i)^2}{\lambda\sigma^2} + \frac{\sum (w_i - W_i)^2}{\sigma^2} \right]$$

and the logarithm likelihood is given by

$$\ln L = -n \ln (\lambda^{1/2} 2\pi) - n \ln (\sigma^2) - \frac{1}{2}\left[\frac{\sum (g_i - \beta W_i)^2}{\lambda\sigma^2} + \frac{\sum (w_i - W_i)^2}{\sigma^2}\right]$$

There are $n + 2$ parameters to estimate: W_i for $i = 1, \ldots, n$, σ^2, and β. Differentiating $\ln L$ with respect to each of these parameters and setting each to zero gives

$$\frac{(g_i - \hat{\beta} W_i)\hat{\beta}}{\lambda\hat{\sigma}^2} + \frac{w_i - \hat{W}_i}{\hat{\sigma}^2} = 0 \tag{B1}$$

$$\frac{-n}{\hat{\sigma}^2} + \frac{1}{2(\hat{\sigma}^2)^2}\left[\frac{1}{\lambda} \sum (g_i - \hat{W}_i \hat{\beta})^2 + \sum (w_i - \hat{W}_i)^2\right] = 0 \tag{B2}$$

and

$$\frac{\sum (g_i - \hat{\beta}\hat{W}_i)\hat{W}_i}{\lambda\hat{\sigma}^2} = 0 \tag{B3}$$

Solving equation (B3) for $\hat{\beta}$ gives

$$\hat{\beta} = \frac{\sum g_i \hat{W}_i}{\sum \hat{W}_i^2} \tag{B4}$$

and solving equation (B1) for $\hat{W}_i$ gives

$$\hat{W}_j = \frac{\lambda w_i + g_i \hat{\beta}}{\lambda + \hat{\beta}^2} \tag{B5}$$

Substituting equation (B5) into equation (B4) and simplifying gives

$$\hat{\beta}^2 \left(\sum g_i w_i\right) + \hat{\beta}\left(\lambda \sum w_i^2 - \sum g_i^2\right) - \lambda\left(\sum g_i w_i\right) = 0 \tag{B6}$$

Solving equation (B6) for $\hat{\beta}$ and using the positive root for the same reasons as explained in reference 21 (section 29.12) for model I give

$$\hat{\beta} = \frac{\left(\sum g_i^2 - \lambda \sum w_i^2\right) + \left[\left(\sum g_i^2 - \lambda \sum w_i^2\right)^2 + 4\lambda \left(\sum g_i w_i\right)^2\right]^{1/2}}{2\sum g_i w_i}$$

and the consistent estimate for $\hat{\sigma}^2$ is

$$\hat{\sigma}^2 = \frac{1}{(n - 1)(\lambda + \hat{\beta}^2)} \sum (g_i - \hat{\beta} w_i)^2$$

Hypothesis Testing of β in Model I

In the particular model considered herein, it is of interest to test if the estimated value of β is significantly different from 1.0 (we also assume as before that $\lambda = 1.0$).

Note that g and w are uncorrelated if and only if $\beta = 0.0$ or $\beta = \infty$. Because of the normally distributed errors, a test for $\beta = 0$ can be replaced by a test for zero correlation. To this end, it is well known (ref. 21, sec. 29.20) that

$$t = \left[\frac{(m - 2)r^2}{1 - r^2}\right]^{1/2} \tag{B7}$$

where

$$r = \frac{v_{gw}}{v_g v_w}$$

is distributed as student's t under the hypothesis that $r = 0$ ($\beta = 0$).

In order to test for β significantly different from 1.0, make the orthogonal transformation of the data

$$x_i = \frac{1}{\sqrt{2}} (g_i + w_i)$$

$$y_i = \frac{1}{\sqrt{2}} (g_i - w_i)$$

It can then be shown that

$$v_x^2 = \frac{1}{2}\left(v_g^2 + 2v_{gw} + v_w^2\right) \tag{B8}$$

$$v_y^2 = \frac{1}{2}\left(v_g^2 - 2v_{gw} + v_w^2\right) \tag{B9}$$

$$v_{xy} = \frac{1}{2}\left(v_g^2 - v_w^2\right) \tag{B10}$$

Then, if and only if $\beta = 1.0$, x and y are uncorrelated. The appropriate test statistic becomes

$$t = \left[\frac{(n - 2)(r')^2}{1 - (r')^2}\right]^{1/2} \tag{B11}$$

where

$$r' = \frac{v_{xy}}{v_x v_y} \tag{B12}$$

Upon substituting equations (B8), (B9), and (B10) into equation (B12) and simplifying, we get

$$\frac{(r')^2}{1 - (r')^2} = \frac{\left(v_g^2 - v_w^2\right)^2}{4\left(v_g^2 v_w^2 - v_{gw}^2\right)} \tag{B13}$$

and hence

$$t = \left[\frac{(n - 2)\left(v_g^2 - v_w^2\right)^2}{4\left(v_g^2 v_w^2 - v_{gw}^2\right)}\right]^{1/2}$$

becomes the appropriate test statistic. This procedure may readily be generalized to other values of β.

REFERENCES

1. Neustadter, Harold E.; King, Robert B.; Fordyce, J. Stuart; and Burr, John C., Jr.: Air Quality Aerometric Data for the City of Cleveland from 1967 to 1970 for Sulfur Dioxide, Suspended Particulates, and Nitrogen Dioxide. NASA TM X-2496, 1972.
2. Neustadter, Harold E.; Sidik, Steven M.; and Burr, John C., Jr.: Statistical Summary and Trend Evaluation of Air Quality Data for Cleveland, Ohio in 1967 to 1971: Total Suspended Particulate, Nitrogen Dioxide, and Sulfur Dioxide. NASA TN D-6935, 1972.
3. Anon.: Federal Register (36FR8186) Apr., 1971.
4. Kramer, David N.; and Mitchel, Paul W.: Evaluation of Filters for High-Volume Sampling of Atmospheric Particulates. Am. Ind. Hyg. Assoc. Jour., vol. 28, no. 3, 1967, pp. 224-228.
5. Larsen, Ralph I.: A Mathematical Model for Relating Air Quality Measurements to Air Quality Standards. U.S. Rept. AP-89, Environmental Protection Agency, Office of Air Programs, Nov. 1971.
6. Anon.: Guidelines: Air Quality Surveillance Network. U.S. Rept. AP-98, Environmental Protection Agency, Office of Air Programs, May 1971.
7. Pate, John B.; and Tabor, Elbert C.: Analytical Aspects of the Use of Glass Fiber Filters for the Collection and Analysis of Atmospheric Particulate Matter. Am. Ind. Hyg. Jour., vol. 23, no. 2, Mar. 1962, pp. 145-150.
8. Anon.: Air Quality Data from the National Air Sampling Networks and Contributing State and Local Networks, 1964-1965. U.S. Dept. of Health, Education and Welfare, Public Health Service, 1966.
9. King, Robert B.; and Fordyce, J. Stuart: Note on a Filter Holder for High-Volume Sampling of Airborne Particulates. Jour. Air Poll. Contr. Assoc., vol. 21, no. 11, Nov. 1971, p. 720.
10. Lockhart, L. B., Jr.; Patterson, R. L., Jr.; and Anderson, W. L.: Characteristics of Air Filter Media Used for Monitoring Airborne Radioactivity. NRL-6054, Naval Research Lab. (AD-600292), Mar. 20, 1964.
11. Fitzgerald, J. J.; and Detwiler, C. G.: Collection Efficiency of Air-Cleaning and Air-Sampling Filter Media. KAPL-1088, Knolls Atomic Power Lab., Mar. 15, 1954.

12. Smith, Walter J.; and Suprenant, Norman F.: Properties of Various Filtering Media for Atmospheric Dust Sampling. Proc. Amer. Soc. for Testing Materials, vol. 53, 1953, pp. 1122-1135.

13. Lindeken, C. L.; Morgin, R. L.; and Petrock, K. F.: Collection Efficiency of Whatman 41 Filter Paper for Submicron Aerosols. Health Physics, vol. 9, no. 3, Mar. 1963, pp. 305-308.

14. Rimberg, David: Penetration of IPC 1478, Whatman 41, and Type 5G Filter Paper as a Function of Particle Size and Velocity. Am. Ind. Hyg. Assoc. Jour., vol. 30, no. 4, July-Aug. 1969, pp. 394-401.

15. Dams, Richard; Rahn, Kenneth A.; and Winchester, John W.: Evaluation of Filter Materials and Impaction Surfaces for Nondestructive Neutron Activation Analysis of Aerosols. Envir. Sci. and Tech., vol. 6, no. 5, May 1972, pp. 441-448.

16. Tierney, Gregory P.; and Conner, William D.: Hygroscopic Effects on Weight Determinations of Particulates Collected on Glass-Fiber Filters. Am. Ind. Hyg. Assoc. Jour., vol. 28, no. 4, July-Aug. 1967, pp. 363-365.

17. Winer, B. J.: Statistical Principles in Experimental Design. McGraw-Hill Book Co., Inc., 1962.

18. Graybill, Franklin A.: An Introduction to Linear Statistical Models. Vol. 1. McGraw-Hill Book Co., Inc., 1967.

19. McKee, Herbert C.; Childers, Ralph E.; Saenz, Oscar, Jr.; Stanley, Thomas W.; and Margeson, John H.: Collaborative Testing of Methods to Measure Air Pollutants, I. The High-Volume Method for Suspended Particulate Matter. Jour. Air Pollution Control Assoc., vol. 22, no. 5, May 1972, pp. 342-347.

20. Clements, H. A.; McMullen, Thomas B.; Thompson, Richard J.; and Akland, Gerald G.: Reproducibility of the Hi-Vol Sampling Method Under Field Conditions. Jour. Air Pollution Control Assoc., vol. 22, no. 12, Dec. 1972, pp. 955-958.

21. Kendall, Maurice G.; and Stuart, Alan: The Advanced Theory of Statistics. Vol. 2. Second ed., Hafner Publ. Co., 1967.

22. Lee, R. E., Jr.; Caldwell, J. S.; and Morgan, G. B.: The Evaluation of Methods for Measuring Suspended Particulates in Air. Atmos. Envir., vol. 6, no. 9, Sept. 1972, pp. 593-622.

23. Morrow, Norman L.; and Briet, Richard S.: Elemental Composition of Suspended Particulate Matter in Metropolitan New York. Envir. Sci. and Tech., vol. 5, no. 9, Sept. 1971, pp. 786-789.

24. Hale, Wayne E.: Sample Size Determination for the Log-Normal Distribution. Atmos. Envir., vol. 6, no. 6, June 1972, pp. 419-422.

25. Hunt, William F., Jr.: The Precision Associated with the Sampling Frequency of Log-Normally Distributed Air Pollutant Measurements. Jour. Air Pollution Control Assoc., vol. 22, no. 9, Sept. 1972, pp. 687-691.

26. Neustadter, Harold E.; and Sidik, Steven M.: On Evaluating Compliance with Air Pollution Levels Not to be Exceeded More Than Once Per Year. NASA TN D-7527, 1974.

TABLE I. - FACTORIAL EXPERIMENT TOTAL SUSPENDED PARTICULATE (TSP) DATA USING GLASS FIBER FILTER

Date	TSP in $\mu g/m^3$				log (TSP in $\mu g/m^3$)			
	High volume serial number							
	14	20	68	63	14	20	68	63
11/8/71	72.0	66.0	64.0	67.0	1.857	1.820	1.806	1.826
11/9/71	47.0	43.0	43.0	44.0	1.672	1.633	1.633	1.643
11/10/71	59.0	55.0	55.0	51.0	1.771	1.740	1.740	1.708
11/11/71	84.0	83.0	81.0	85.0	1.924	1.919	1.908	1.929
11/15/71	55.0	56.0	57.5	58.6	1.740	1.748	1.760	1.768
11/16/71	105.0	102.0	101.0	99.0	2.021	2.009	2.004	1.996
11/17/71	92.0	88.0	82.0	73.0	1.964	1.944	1.914	1.863
11/18/71	38.6	39.4	36.8	35.2	1.587	1.595	1.566	1.547
11/22/71	49.0	45.0	47.4	40.0	1.690	1.653	1.676	1.602
Mean	66.8	64.2	63.1	61.4	1.803	1.785	1.779	1.765

TABLE II. - FACTORIAL EXPERIMENTAL TOTAL SUSPENDED PARTICULATE (TSP) DATA USING WHATMAN-41

Date	TSP in $\mu g/m^3$					log (TSP in $\mu g/m^3$)				
	High volume serial number									
	14	20	68	63	71	14	20	68	63	71
1/24/72	61.3	62.7	63.2	66.0	67.0	1.787	1.797	1.826	1.801	1.820
1/25/72	47.7	52.4	60.0	56.5	55.2	1.679	1.719	1.742	1.778	1.752
1/26/72	69.0	71.3	72.0	74.2	64.8	1.839	1.853	1.842	1.857	1.870
1/27/72	45.3	43.5	47.2	50.5	47.2	1.656	1.638	1.674	1.674	1.703
Mean	55.8	57.5	60.6	61.8	58.5	1.740	1.752	1.763	1.777	1.786

TABLE III. - ANALYSIS OF VARIANCE (ANOVA) TABLES

(a) Raw values for Whatman-41 filter. Mean of all observations, 58.8; $\hat{\sigma}_w = 2.805$; F = (mean square due to samplers)/(mean square due to error) = MS(s)/MS(δ) = 2.91

Source of variability	Sum of squares, SSQ	Degrees of freedom	Mean square, MS	Expected mean square
Days, d	1619.8	3	539.89	$\sigma_w^2 + 5\sigma_d^2$
Samplers, s	91.58	4	22.90	$\sigma_w^2 + 4\sigma_s^2$
Error, δ	94.48	12	7.87	σ_w^2

(b) Log transformed data for Whatman-41 filter. Mean of all observations, 1.76; $\hat{\sigma}_w = 0.0213$; F = (mean square due to samplers)/(mean square due to error) = MS(s)/MS(δ) = 3.07

Source of variability	Sum of squares, SSQ	Degrees of freedom	Mean square, MS	Expected mean square
Days, d	0.092216	3	0.030739	$\sigma_w^2 + 5\sigma_d^2$
Samplers, s	.005559	4	.001390	$\sigma_w^2 + 4\sigma_s^2$
Error, δ	.005439	12	.000453	σ_w^2

(c) Raw values for glass fiber filter. Mean of all observations, 63.9; $\hat{\sigma}_g = 3.124$; F = (mean square due to samplers)/(mean square due to error) = MS(s)/MS(ϵ) = 4.78

Source of variability	Sum of squares, SSQ	Degrees of freedom	Mean square, MS	Expected mean square
Days, d	15 077.78	8	1884.72	$\sigma_g^2 + 4\sigma_d^2$
Samplers, s	139.93	3	46.64	$\sigma_{\epsilon}^2 + 9\sigma_s^2$
Error, ϵ	234.30	24	9.76	σ_g^2

(d) Log transformed data for glass fiber filter. Mean of all observations, 1.78; $\hat{\sigma}_g = 0.0207$; F = (mean square due to samplers)/(mean square due to error) = MS(s)/MS(ϵ) = 5.29

Source of variability	Sum of squares, SSQ	Degrees of freedom	Mean square, MS	Expected mean square
Days, d	0.688213	8	0.086027	$\sigma_g^2 + 4\sigma_d^2$
Samplers, s	.006807	3	.002269	$\sigma_g^2 + 9\sigma_s^2$
Error, ϵ	.010308	24	.000429	σ_g^2

TABLE IV. - ESTIMATES OF VARIANCE COMPONENTS

FROM ANALYSIS OF VARIANCE (ANOVA) TABLES

Source of variability	Raw data	Log transformed data
Glass fiber error:		
$\hat{\sigma}_g^2$	9.76	0.000429
$\hat{\sigma}_g$	3.12	.0207
Whatman-41 error:		
$\hat{\sigma}_w^2$	7.87	0.000453
$\hat{\sigma}_w$	2.81	.0213
Pooled error:		
$\hat{\sigma}^2$	9.13	0.000437
$\hat{\sigma}$	3.02	.0209
Sampler variability:		
$\hat{\sigma}_s$ - GF data	2.02	0.0143
$\hat{\sigma}_s$ - W41 data	1.94	.0153
Total variability:		
$\hat{\sigma}_t^2$	13.06	0.000656
$\hat{\sigma}_t$	3.61	.0256

TABLE V. - TOTAL SUSPENDED PARTICULATE (TSP) CONCENTRATIONS FOR GLASS FIBER AND WHATMAN-41 FILTERS

(a) Station 1

DATE	W41	GF	GF-W41	LOG(W41)	LOG(GF)	LOG(GF)-LOG(W41)	
8 10 71	279.00	326.00	49.00	2.4456	2.5159	0.70270E-01	1
8 16 71	122.00	138.00	16.00	2.0864	2.1399	0.53520E-01	2
8 22 71	130.00	139.00	9.00	2.1139	2.1430	0.29072E-01	3
8 25 71	192.00	215.00	23.00	2.2833	2.3324	0.49136E-01	4
8 26 71	105.00	103.00	-2.00	2.0212	2.0126	-0.93523E-02	5
8 31 71	152.00	134.00	-18.00	2.1818	2.1271	-0.54739E-01	6
9 6 71	199.00	186.00	-13.00	2.2989	2.2695	-0.29340E-01	7
9 9 71	214.00	199.00	-15.00	2.3304	2.2989	-0.31561E-01	8
9 15 71	196.00	229.00	33.00	2.2923	2.3598	0.67579E-01	9
9 18 71	88.00	95.00	7.00	1.9445	1.9777	0.33240E-01	10
9 24 71	88.00	112.00	24.00	1.9445	2.0492	0.10474	11
12 11 71	94.00	108.00	14.00	1.9731	2.0334	0.60296E-01	12
12 14 71	218.00	329.00	111.00	2.3385	2.5172	0.17874	13
12 20 71	73.00	128.00	55.00	1.8633	2.1072	0.24389	14
12 26 71	83.00	83.00	0.00	1.9191	1.9191	0.00000	15
12 29 71	115.00	161.00	46.00	2.0607	2.2068	0.14613	16
1 13 72	130.00	186.00	56.00	2.1139	2.2695	0.15557	17
1 16 72	168.00	95.00	-73.00	2.2253	1.9777	-0.24759	18
1 19 72	146.00	181.00	35.00	2.1644	2.2577	0.93326E-01	19
1 25 72	255.00	285.00	30.00	2.4065	2.4548	0.48305E-01	20
2 12 72	216.40	315.00	98.60	2.3353	2.4983	0.16306	21
2 15 72	108.60	147.00	38.40	2.0358	2.1673	0.13150	22
3 22 72	116.90	148.00	31.10	2.0678	2.1703	0.10245	23
4 3 72	186.00	217.00	31.00	2.2695	2.3365	0.66946E-01	24
4 6 72	186.90	230.00	43.10	2.2716	2.3617	0.90122E-01	25
4 9 72	132.80	144.00	11.20	2.1232	2.1584	0.35174E-01	26
4 12 72	250.70	270.00	19.30	2.3992	2.4314	0.32210E-01	27
4 15 72	208.80	248.00	39.20	2.3197	2.3945	0.74727E-01	28
4 18 72	214.40	277.00	62.60	2.3312	2.4425	0.11126	29
4 21 72	140.00	148.00	8.00	2.1461	2.1703	0.24134E-01	30
4 27 72	124.50	154.00	29.50	2.0952	2.1875	0.92352E-01	31
5 9 72	65.40	65.00	-0.40	1.8156	1.8129	-0.26541E-02	32
5 18 72	241.80	306.00	64.20	2.3835	2.4857	0.10227	33
5 21 72	226.70	238.00	11.30	2.3554	2.3766	0.21127E-01	34
5 24 72	270.06	326.00	55.94	2.4315	2.5132	0.81754E-01	35
5 27 72	339.38	353.00	13.63	2.5307	2.5478	0.17095E-01	36
6 2 72	162.20	221.00	58.80	2.2100	2.3444	0.13434	37
6 8 72	301.88	321.00	19.13	2.4798	2.5065	0.26678E-01	38
7 2 72	147.60	199.00	51.40	2.1691	2.2989	0.12977	39
7 11 72	225.70	264.00	38.30	2.3535	2.4216	0.68073E-01	40
7 14 72	270.69	227.00	-43.69	2.4325	2.3560	-0.76443E-01	41
7 20 72	307.38	268.00	-39.38	2.4877	2.4281	-0.59533E-01	42
7 29 72	85.20	113.00	27.80	1.9304	2.0531	0.12264	43
8 1 72	227.50	313.00	85.50	2.3570	2.4955	0.13856	44
8 7 72	139.60	143.00	3.40	2.1449	2.1553	0.10457E-01	45
8 10 72	175.20	231.00	55.80	2.2435	2.3636	0.12008	46
8 13 72	290.06	324.00	33.94	2.4625	2.5105	0.48054E-01	47
8 22 72	191.30	237.00	45.70	2.2817	2.3747	0.93040E-01	48
8 25 72	198.10	172.00	-26.10	2.2969	2.2355	-0.61351E-01	49
8 31 72	419.69	325.00	-94.69	2.6229	2.5119	-0.11104	50
9 3 72	50.40	39.00	-11.40	1.7024	1.5911	-0.11135	51
9 6 72	364.06	331.00	-33.06	2.5612	2.5198	-0.41348E-01	52
9 9 72	51.40	64.00	12.60	1.7109	1.8062	0.95230E-01	53
9 12 72	162.20	208.00	45.80	2.2100	2.3181	0.10801	54
9 18 72	173.80	166.00	-7.80	2.2400	2.2201	-0.19534E-01	55
9 21 72	319.25	266.00	-53.25	2.5041	2.4249	-0.79250E-01	56
9 24 72	198.30	174.00	-24.30	2.2973	2.2405	-0.56767E-01	57

MEAN 184.87 203.96 0.45326E-01

CORRELATION COEFFICIENT 0.867

COEFFICIENTS OF BEST FITTING STRAIGHT LINE --FIRST SET IS NOT FORCED THROUGH ORIGIN, SECOND SET IS FORCED

INTERCEPT	SLOPE	ERROR STD DEV
16.45	1.014	27.80
0.00	1.091	27.88

T VALUE FOR TEST OF BETA 0.20 DEGREES OF FREEDOM 55

ANALYSIS OF LOGS--

MEAN DIFFERENCE 0.45326E-01

T-STATISTIC 3.99

STD DEV 0.85866E-01

DEGREES OF FREEDOM 56

TABLE V. - Continued. TOTAL SUSPENDED PARTICULATE (TSP) CONCENTRATIONS FOR GLASS FIBER AND WHATMAN-41 FILTERS

(b) Station 3

STATION NUMBER 3

DATE	W41	GF	GF-W41	LOG(W41)	LOG(GF)	LOG(GF)-LOG(W41)	
8 22 71	78.00	74.00	-4.00	1.8921	1.8692	-0.22863E-01	1
8 25 71	110.00	121.00	11.00	2.0414	2.0828	0.41393E-01	2
8 26 71	83.00	107.00	24.00	1.9191	2.0294	0.11031	3
9 15 71	137.00	138.00	1.00	2.1367	2.1399	0.31586E-02	4
9 18 71	210.00	229.00	19.00	2.3222	2.3598	0.37616E-01	5
9 30 71	194.00	256.00	62.00	2.2878	2.4082	0.12044	6
10 2 71	136.00	175.00	39.00	2.1335	2.2430	0.10950	7
10 6 71	46.00	51.00	5.00	1.6628	1.7076	0.44813E-01	8
10 9 71	40.00	37.00	-3.00	1.6021	1.5682	-0.33858E-01	9
10 12 71	74.00	73.00	-1.00	1.8692	1.8633	-0.59090E-02	10
10 16 71	140.00	148.00	8.00	2.1461	2.1703	0.24134E-01	11
10 21 71	162.00	154.00	-8.00	2.2095	2.1875	-0.21994E-01	12
10 27 71	124.00	117.00	-7.00	2.0934	2.0682	-0.25236E-01	13
10 30 71	199.00	236.00	37.00	2.2989	2.3729	0.74059E-01	14
11 2 71	88.00	82.00	-6.00	1.9445	1.9138	-0.30669E-01	15
11 5 71	80.00	87.00	7.00	1.9031	1.9395	0.36429E-01	16
11 11 71	59.00	106.00	47.00	1.7709	2.0253	0.25445	17
11 17 71	126.00	136.00	10.00	2.1004	2.1335	0.33168E-01	18
12 2 71	101.00	97.00	-4.00	2.0043	1.9868	-0.17550E-01	19
12 8 71	54.00	93.00	39.00	1.7324	1.9685	0.23609	20
12 11 71	68.00	78.00	10.00	1.8325	1.8921	0.59587E-01	21
12 20 71	48.00	60.00	12.00	1.6812	1.7782	0.96910E-01	22
12 26 71	54.00	44.00	-10.00	1.7324	1.6435	-0.88941E-01	23
1 7 72	50.00	56.00	6.00	1.6990	1.7482	0.49218E-01	24
1 16 72	39.00	54.00	15.00	1.5911	1.7324	0.14133	25
1 22 72	59.00	74.00	15.00	1.7709	1.8692	0.98379E-01	26
1 25 72	131.00	124.00	-7.00	2.1173	2.0934	-0.23849E-01	27
1 28 72	29.00	86.00	57.00	1.4624	1.9345	0.47210	28
2 3 72	48.10	52.00	3.90	1.6821	1.7160	0.33678E-01	29
2 6 72	32.70	47.00	14.30	1.5145	1.6721	0.15756	30
2 9 72	99.10	135.00	35.90	1.9961	2.1303	0.13427	31
2 12 72	127.40	180.00	52.60	2.1052	2.2553	0.15011	32
2 15 72	46.70	45.00	-1.70	1.6693	1.6532	-0.16097E-01	33
2 21 72	123.20	137.00	13.80	2.0906	2.1367	0.46113E-01	34
2 24 72	89.40	105.00	15.60	1.9513	2.0212	0.69860E-01	35
2 27 72	92.50	99.00	6.50	1.9661	1.9956	0.29493E-01	36
3 1 72	83.70	81.00	-2.70	1.9227	1.9085	-0.14236E-01	37
3 4 72	95.70	107.00	11.30	1.9809	2.0294	0.48476E-01	38
3 7 72	111.40	139.00	27.60	2.0469	2.1430	0.96136E-01	39
3 10 72	88.30	118.00	29.70	1.9459	2.0719	0.12594	40
3 16 72	72.60	97.00	24.20	1.8621	1.9868	0.12466	41
3 19 72	100.80	112.00	11.20	2.0034	2.0492	0.45772E-01	42
3 22 72	79.00	51.00	-28.00	1.8976	1.7076	-0.19006	43
3 25 72	56.90	76.00	19.10	1.7551	1.8808	0.12571	44
3 28 72	140.00	217.00	77.00	2.1461	2.3365	0.19033	45
4 3 72	102.10	125.00	22.90	2.0090	2.0969	0.87894E-01	46
4 6 72	150.40	217.00	66.60	2.1772	2.3365	0.15922	47
4 9 72	101.00	127.00	26.00	2.0043	2.1038	0.99483E-01	48
4 12 72	192.00	238.00	46.00	2.2833	2.3766	0.93276E-01	49
4 15 72	104.00	133.00	29.00	2.0170	2.1239	0.10682	50
4 18 72	124.80	169.00	44.20	2.0962	2.2279	0.13168	51
4 21 72	157.80	155.00	-2.80	2.1981	2.1903	-0.77667E-02	52
4 27 72	128.80	193.00	64.20	2.1099	2.2856	0.17565	53
4 30 72	108.20	136.00	27.80	2.0342	2.1335	0.99315E-01	54
5 3 72	85.60	103.00	17.40	1.9325	2.0128	0.80375E-01	55
5 6 72	192.40	176.00	-16.40	2.2842	2.2455	-0.38690E-01	56
5 9 72	100.10	97.00	-3.10	2.0004	1.9868	-0.13652E-01	57
5 15 72	79.70	100.00	20.30	1.9015	2.0000	0.98546E-01	58
5 18 72	155.90	201.00	45.10	2.1928	2.3032	0.11035	59
5 21 72	129.50	149.00	19.50	2.1123	2.1732	0.60917E-01	60
5 24 72	198.00	309.00	111.00	2.2967	2.4900	0.19329	61
6 2 72	87.60	102.00	14.40	1.9425	2.0086	0.66107E-01	62
6 8 72	134.20	119.00	-15.20	2.1277	2.0755	-0.52203E-01	63
6 11 72	42.90	71.00	28.10	1.6324	1.8513	0.21882	64
6 14 72	65.40	84.00	18.60	1.8156	1.9243	0.10871	65
6 17 72	100.20	113.00	12.80	2.0009	2.0531	0.52214E-01	66
6 20 72	96.50	97.00	0.50	1.9845	1.9868	0.22449E-02	67
6 26 72	67.50	109.00	41.50	1.8293	2.0374	0.20812	68
6 29 72	92.50	133.00	40.50	1.9661	2.1239	0.15771	69
7 2 72	70.30	119.00	48.70	1.8469	2.0755	0.22861	70
7 8 72	58.00	108.00	50.00	1.7634	2.0334	0.27000	71
7 11 72	95.20	125.00	29.80	1.9786	2.0969	0.11826	72
7 14 72	84.50	97.00	12.50	1.9269	1.9868	0.59516E-01	73
7 20 72	126.10	134.00	7.90	2.1007	2.1271	0.26399E-01	74
7 29 72	101.90	132.00	30.10	2.0082	2.1206	0.11241	75
8 1 72	87.70	117.00	29.30	1.9430	2.0682	0.12519	76
8 7 72	50.20	59.00	8.80	1.7007	1.7709	0.70155E-01	77
8 10 72	35.00	96.00	61.00	1.5441	1.9823	0.43820	78
8 13 72	93.50	172.00	78.50	1.9708	2.2355	0.26472	79
8 16 72	94.70	87.00	-7.70	1.9763	1.9395	-0.36627E-01	80
8 19 72	124.10	65.00	-59.10	2.0938	1.8129	-0.28085	81
8 22 72	95.10	103.00	7.90	1.9782	2.0128	0.34667E-01	82
8 25 72	58.30	106.00	47.70	1.7656	2.0253	0.25966	83
8 31 72	101.60	183.00	81.40	2.0069	2.2625	0.25557	84
9 3 72	52.10	54.00	1.90	1.7168	1.7324	0.15575E-01	85
9 6 72	84.40	100.00	15.60	1.9263	2.0000	0.73666E-01	86
9 9 72	45.40	53.00	7.60	1.6570	1.7243	0.67235E-01	87
9 12 72	154.40	219.00	64.60	2.1886	2.3404	0.15180	88
9 18 72	37.60	60.00	22.40	1.5752	1.7782	0.20299	89
9 21 72	63.70	86.00	22.30	1.8041	1.9345	0.13036	90
9 24 72	48.60	61.00	12.40	1.6866	1.7853	0.98715E-01	91

MEAN 96.33 117.40 0.85879E-01

CORRELATION COEFFICIENT 0.676

COEFFICIENTS OF BEST FITTING STRAIGHT LINE --FIRST SET IS NOT FORCED THROUGH ORIGIN, SECOND SET IS FORCED

INTERCEPT	SLOPE	ERROR STD DEV
-8.46	1.307	16.63
0.00	1.231	16.66

T VALUE FOR TEST OF BETA 4.6 DEGREES OF FREEDOM 89

ANALYSIS OF LOGS--

MEAN DIFFERENCE 0.85879E-01

T-STATISTIC 7.50

STD DEV 0.10926

DEGREES OF FREEDOM 90

TABLE V. - Continued. TOTAL SUSPENDED PARTICULATE (TSP) CONCENTRATIONS FOR GLASS FIBER AND WHATMAN-41 FILTERS

(c) Station 4

DATE	W41	GF	GF-W41	LOG (W41)	LOG (GF)	LOG (GF) - LOG (W41)	
12 26 71	66.00	60.00	-6.00	1.8195	1.7782	-0.41393E-01	1
12 29 71	157.00	120.00	-37.00	2.1959	2.0792	-0.11672	2
1 7 72	154.00	80.00	-74.00	2.1875	1.9031	-0.28443	3
1 16 72	99.00	82.00	-17.00	1.9956	1.9138	-0.81821E-01	4
1 19 72	109.00	83.00	-26.00	2.0374	1.9191	-0.11835	5
1 22 72	87.00	57.00	-30.00	1.9395	1.7559	-0.18364	6
1 25 72	208.00	169.00	-39.00	2.3181	2.2279	-0.90177E-01	7
1 28 72	71.00	69.00	-2.00	1.8513	1.8388	-0.12409E-01	8
2 3 72	85.40	58.00	-27.40	1.9314	1.7634	-0.16802	9
2 12 72	290.75	150.00	-140.75	2.4635	2.1761	-0.28743	10
2 15 72	51.70	52.00	0.30	1.7135	1.7160	0.25187E-02	11
2 21 72	195.40	121.00	-74.40	2.2909	2.0828	-0.20814	12
2 24 72	74.30	76.00	1.70	1.8710	1.8808	0.98429E-02	13
2 27 72	157.70	111.00	-46.70	2.1978	2.0453	-0.15251	14
3 1 72	137.50	83.00	-54.50	2.1383	1.9191	-0.21922	15
3 4 72	157.20	121.00	-36.20	2.1965	2.0828	-0.11366	16
3 7 72	171.80	127.00	-44.80	2.2350	2.1038	-0.13121	17
3 10 72	157.50	122.00	-35.50	2.1973	2.0864	-0.11092	18
3 16 72	64.00	88.00	24.00	1.8062	1.9445	0.13830	19
3 19 72	83.50	69.00	-14.50	1.9217	1.8388	-0.82837E-01	20
3 22 72	54.20	43.00	-11.20	1.7340	1.6335	-0.10052	21
4 15 72	105.70	122.00	16.30	2.0241	2.0864	0.62287E-01	22
4 18 72	177.80	117.00	-60.80	2.2499	2.0682	-0.18174	23
4 21 72	145.80	85.00	-60.80	2.1637	1.9294	-0.23433	24
4 27 72	61.50	68.00	6.50	1.7889	1.8325	0.43633E-01	25
4 30 72	142.60	118.00	-24.60	2.1541	2.0719	-0.62231E-01	26
5 6 72	281.19	164.00	-117.19	2.4490	2.2148	-0.23415	27
5 9 72	56.50	64.00	7.50	1.7520	1.8062	0.54132E-01	28
5 15 72	107.60	91.00	-16.60	2.0318	1.9590	-0.72762E-01	29
5 18 72	142.00	147.00	5.00	2.1523	2.1673	0.15030E-01	30
5 21 72	166.20	126.00	-40.20	2.2206	2.1004	-0.12026	31
5 24 72	201.50	115.00	-86.50	2.3043	2.0607	-0.24358	32
5 27 72	206.20	133.00	-73.20	2.3143	2.1239	-0.19044	33
6 2 72	237.10	174.00	-63.10	2.3749	2.2405	-0.13438	34
6 11 72	89.00	84.00	-5.00	1.9494	1.9243	-0.25110E-01	35
6 14 72	107.40	106.00	-1.40	2.0310	2.0253	-0.56915E-02	36
6 17 72	83.20	67.00	-16.20	1.9201	1.8261	-0.94045E-01	37
7 11 72	200.00	106.00	-94.00	2.3010	2.0253	-0.27572	38
7 14 72	141.50	48.00	-93.50	2.1508	1.6812	-0.46951	39
7 29 72	56.40	70.00	13.60	1.7513	1.8451	0.93631E-01	40
8 1 72	142.80	101.00	-41.80	2.1547	2.0043	-0.15040	41
8 7 72	93.80	85.00	-8.80	1.9722	1.9294	-0.42769E-01	42
8 10 72	113.80	116.00	2.20	2.0561	2.0645	0.83275E-02	43
8 16 72	149.80	107.00	-42.80	2.1755	2.0294	-0.14612	44
8 19 72	76.90	60.00	-16.90	1.8859	1.7782	-0.10777	45
8 22 72	143.70	106.00	-37.70	2.1575	2.0253	-0.13215	46
8 25 72	121.50	114.00	-7.50	2.0846	2.0569	-0.27671E-01	47
8 31 72	169.80	137.00	-32.80	2.2299	2.1367	-0.93208E-01	48
9 3 72	33.60	24.00	-9.60	1.5263	1.3802	-0.14610	49
9 9 72	43.60	44.00	0.40	1.6395	1.6435	0.39902E-02	50
9 12 72	127.10	114.00	-13.10	2.1041	2.0569	-0.47233E-01	51
9 18 72	59.60	59.00	-0.60	1.7752	1.7709	-0.43764E-02	52
9 21 72	112.10	91.00	-21.10	2.0496	1.9590	-0.90555E-01	53
MEAN	126.97	96.30				-0.10234	

CORRELATION COEFFICIENT 0.847

COEFFICIENTS OF BEST FITTING STRAIGHT LINE --FIRST SET IS NOT FORCED THROUGH ORIGIN, SECOND SET IS FORCED

INTERCEPT	SLOPE	ERROR STD DEV
28.49	0.534	16.34
0.00	0.725	18.71

T VALUE FOR TEST OF BETA 7.6 DEGREES OF FREEDOM 51

ANALYSIS OF LOGS--

MEAN DIFFERENCE -0.10234

T-STATISTIC -6.76

STD DEV 0.11015

DEGREES OF FREEDOM 52

TABLE V. - Continued. TOTAL SUSPENDED PARTICULATE (TSP) CONCENTRATIONS FOR GLASS FIBER AND WHATMAN-41 FILTERS

(d) Station 5

DATE	W41	GF	GF-W41	LOG (W41)	LOG (GF)	LOG (GF) - LOG (W41)	
9 18 71	63.00	58.00	-5.00	1.7993	1.7634	-0.35913E-01	1
9 21 71	128.00	139.00	11.00	2.1072	2.1430	0.35806E-01	2
9 24 71	103.00	97.00	-6.00	2.0128	1.9868	-0.26065E-01	3
9 30 71	127.00	69.00	-58.00	2.1038	1.8388	-0.26495	4
10 2 71	114.00	122.00	8.00	2.0569	2.0864	0.29454E-01	5
10 6 71	111.00	112.00	1.00	2.0453	2.0492	0.38958E-02	6
10 9 71	51.00	49.00	-2.00	1.7076	1.6902	-0.17374E-01	7
10 12 71	112.00	98.00	-14.00	2.0492	1.9912	-0.57992E-01	8
10 18 71	152.00	156.00	4.00	2.1818	2.1931	0.11281E-01	9
10 21 71	130.00	108.00	-22.00	2.1139	2.0334	-0.80520E-01	10
10 24 71	55.00	47.00	-8.00	1.7404	1.6721	-0.68265E-01	11
10 27 71	145.00	126.00	-19.00	2.1614	2.1004	-0.60998E-01	12
10 30 71	177.00	183.00	6.00	2.2480	2.2625	0.14479E-01	13
1 13 72	71.00	66.00	-5.00	1.8513	1.8195	-0.31714E-01	14
1 16 72	48.00	45.00	-3.00	1.6812	1.6532	-0.28028E-01	15
1 19 72	106.00	125.00	19.00	2.0253	2.0969	0.71604E-01	16
1 22 72	74.00	74.00	0.00	1.8692	1.8692	0.00000	17
1 28 72	88.00	111.00	23.00	1.9445	2.0453	0.10084	18
2 3 72	68.70	65.00	-3.70	1.8370	1.8129	-0.24038E-01	19
2 15 72	80.40	68.00	-12.40	1.9052	1.8325	-0.72739E-01	20
2 21 72	116.60	102.00	-14.60	2.0667	2.0086	-0.58090E-01	21
2 24 72	118.40	113.00	-5.40	2.0733	2.0531	-0.20268E-01	22
2 27 72	93.90	85.00	-8.90	1.9727	1.9294	-0.43240E-01	23
3 1 72	82.20	71.00	-11.20	1.9149	1.8513	-0.63609E-01	24
3 4 72	122.80	114.00	-8.80	2.0892	2.0569	-0.32282E-01	25
3 7 72	108.50	99.00	-9.50	2.0354	1.9956	-0.39795E-01	26
3 10 72	119.00	114.00	-5.00	2.0755	2.0569	-0.18641E-01	27
3 28 72	60.60	86.00	25.40	1.7825	1.9345	0.15204	28
4 6 72	120.60	139.00	18.40	2.0813	2.1430	0.61676E-01	29
4 12 72	140.80	181.00	40.20	2.1486	2.2577	0.10909	30
4 15 72	98.20	131.00	32.80	1.9921	2.1173	0.12516	31
4 18 72	108.20	113.00	4.80	2.0342	2.0531	0.18854E-01	32
4 21 72	109.10	121.00	11.90	2.0378	2.0828	0.44971E-01	33
4 27 72	89.60	115.00	25.40	1.9523	2.0607	0.10840	34
4 30 72	103.00	106.00	3.00	2.0128	2.0253	0.12469E-01	35
5 6 72	127.10	145.00	17.90	2.1041	2.1614	0.57231E-01	36
5 9 72	71.50	60.00	-11.50	1.8543	1.7782	-0.76155E-01	37
5 15 72	96.30	108.00	11.70	1.9836	2.0334	0.49811E-01	38
5 18 72	218.70	248.00	29.30	2.3398	2.3945	0.54605E-01	39
5 21 72	173.20	182.00	8.80	2.2385	2.2601	0.21526E-01	40
5 24 72	159.00	194.00	35.00	2.2014	2.2878	0.86405E-01	41
5 27 72	129.20	140.00	10.80	2.1113	2.1461	0.34868E-01	42
6 2 72	122.60	128.00	5.40	2.0885	2.1072	0.18727E-01	43
6 11 72	65.20	94.00	28.80	1.8142	1.9731	0.15889	44
6 17 72	79.30	74.00	-5.30	1.8993	1.8692	-0.30025E-01	45
6 20 72	102.00	93.00	-9.00	2.0086	1.9685	-0.40116E-01	46
6 29 72	100.40	120.00	19.60	2.0017	2.0792	0.77455E-01	47
7 8 72	71.50	108.00	36.50	1.8543	2.0334	0.17912	48
7 11 72	135.50	141.00	5.50	2.1319	2.1492	0.17280E-01	49
7 14 72	100.20	100.00	-0.20	2.0009	2.0000	-0.86403E-03	50
7 20 72	49.80	136.00	86.20	1.6972	2.1335	0.43634	51
7 29 72	51.60	68.00	16.40	1.7126	1.8325	0.11988	52
8 1 72	94.90	129.00	34.10	1.9773	2.1106	0.13333	53
8 7 72	24.90	80.00	55.10	1.3962	1.9031	0.50692	54
8 10 72	47.40	96.00	48.60	1.6758	1.9823	0.30651	55
8 13 72	91.80	133.00	41.20	1.9628	2.1239	0.16102	56
8 16 72	101.20	95.00	-6.20	2.0052	1.9777	-0.27453E-01	57
8 19 72	69.60	79.00	9.40	1.8426	1.8976	0.55033E-01	58
8 22 72	80.80	103.00	22.20	1.9074	2.0128	0.10544	59
8 25 72	71.20	126.00	54.80	1.8525	2.1004	0.24790	60
8 31 72	75.00	145.00	70.00	1.8751	2.1614	0.28631	61
9 3 72	30.70	31.00	0.30	1.4871	1.4914	0.42334E-02	62
9 9 72	41.60	33.00	-8.60	1.6191	1.5185	-0.10055	63
9 12 72	93.80	131.00	37.20	1.9722	2.1173	0.14508	64
9 21 72	76.40	101.00	24.60	1.8831	2.0043	0.12124	65
9 24 72	61.00	71.00	10.00	1.7853	1.8513	0.65928E-01	66

MEAN 97.10 107.58 0.45930E-01
CORRELATION COEFFICIENT 0.812
COEFFICIENTS OF BEST FITTING STRAIGHT LINE --FIRST SET IS NOT FORCED THROUGH ORIGIN, SECOND SET IS FORCED

INTERCEPT	SLOPE	ERROR STD DEV
-0.11	1.109	16.58
0.00	1.108	16.45

T VALUE FOR TEST OF BETA 1.2 DEGREES OF FREEDOM 64
ANALYSIS OF LOGS--
MEAN DIFFERENCE 0.45930E-01
T-STATISTIC 3.08
STD DEV 0.12130
DEGREES OF FREEDOM 65

TABLE V. - Continued. TOTAL SUSPENDED PARTICULATE (TSP) CONCENTRATIONS FOR GLASS FIBER AND WHATMAN-41 FILTERS

(e) Station 6

DATE	W41	GF	GF-W41	LOG (W41)	LOG (GF)	LOG (GF)-LOG (W41)	
8 25 71	106.00	111.00	5.00	2.0253	2.0453	0.20017E-01	1
9 15 71	128.00	106.00	-22.00	2.1072	2.0253	-0.81503E-01	2
9 24 71	38.00	46.00	8.00	1.5798	1.6628	0.82973E-01	3
12 8 71	142.00	156.00	14.00	2.1523	2.1931	0.40837E-01	4
12 20 71	83.00	98.00	15.00	1.9191	1.9912	0.72148E-01	5
12 29 71	92.00	138.00	46.00	1.9638	2.1399	0.17609	6
1 4 72	101.00	111.00	10.00	2.0043	2.0453	0.41001E-01	7
1 16 72	66.00	96.00	30.00	1.8195	1.9823	0.16273	8
3 16 72	106.60	90.00	-16.60	2.0277	1.9542	-0.73505E-01	9
3 19 72	66.60	62.00	-4.60	1.8235	1.7924	-0.31067E-01	10
3 22 72	62.40	54.00	-8.40	1.7952	1.7324	-0.62780E-01	11
3 25 72	34.00	37.00	3.00	1.5315	1.5682	0.36722E-01	12
3 29 72	102.00	100.00	-2.00	2.0086	2.0000	-0.85993E-02	13
4 3 72	141.70	126.00	-15.70	2.1514	2.1004	-0.50997E-01	14
4 6 72	107.70	109.00	1.30	2.0322	2.0374	0.52137E-02	15
4 9 72	81.80	72.00	-9.80	1.9127	1.8573	-0.55404E-01	16
4 12 72	202.80	149.00	-53.80	2.3071	2.1732	-0.13387	17
4 15 72	98.00	99.00	1.00	1.9912	1.9956	0.44088E-02	18
4 18 72	143.20	109.00	-34.20	2.1559	2.0374	-0.11852	19
4 21 72	73.00	63.00	-10.00	1.8633	1.7993	-0.63962E-01	20
4 27 72	77.90	86.00	8.10	1.8915	1.9345	0.42970E-01	21
4 30 72	118.20	87.00	-31.20	2.0726	1.9395	-0.13310	22
5 3 72	97.20	82.00	-15.20	1.9877	1.9138	-0.73849E-01	23
5 6 72	203.70	147.00	-56.70	2.3090	2.1673	-0.14167	24
5 9 72	79.20	63.00	-16.20	1.8987	1.7993	-0.99380E-01	25
5 15 72	103.30	100.00	-3.30	2.0141	2.0000	-0.14087E-01	26
5 18 72	172.80	156.00	-16.80	2.2375	2.1931	-0.44411E-01	27
5 21 72	141.40	121.00	-20.40	2.1504	2.0828	-0.67658E-01	28
5 24 72	182.40	172.00	-10.40	2.2610	2.2355	-0.25493E-01	29
6 2 72	164.30	107.00	-57.30	2.2156	2.0294	-0.18624	30
6 8 72	239.30	160.00	-79.30	2.3789	2.2041	-0.17482	31
6 14 72	115.00	89.00	-26.00	2.0607	1.9494	-0.11131	32
6 17 72	94.30	66.00	-28.30	1.9745	1.8195	-0.15495	33
6 26 72	136.10	91.00	-45.10	2.1339	1.9590	-0.17481	34
6 29 72	90.70	88.00	-2.70	1.9576	1.9445	-0.13121E-01	35
7 2 72	83.10	98.00	14.90	1.9196	1.9912	0.71638E-01	36
7 8 72	67.50	89.00	21.50	1.8293	1.9494	0.12009	37
7 11 72	167.10	132.00	-35.10	2.2230	2.1206	-0.10240	38
7 14 72	165.30	107.00	-58.30	2.2183	2.0294	-0.18888	39
7 20 72	173.90	120.00	-53.90	2.2403	2.0792	-0.16111	40
8 1 72	162.20	132.00	-30.20	2.2100	2.1206	-0.89475E-01	41
8 10 72	154.10	142.00	-12.10	2.1878	2.1523	-0.35508E-01	42
8 13 72	146.80	127.00	-19.80	2.1667	2.1038	-0.62913E-01	43
8 16 72	168.90	110.00	-58.90	2.2276	2.0414	-0.18623	44
8 19 72	95.40	287.00	191.60	1.9795	2.4579	0.47834	45
8 22 72	127.10	104.00	-23.10	2.1041	2.0170	-0.87104E-01	46
8 31 72	190.20	120.00	-70.20	2.2792	2.0792	-0.20003	47
9 3 72	35.90	23.00	-12.90	1.5551	1.3617	-0.19335	48
9 6 72	199.00	133.00	-66.00	2.2989	2.1239	-0.17500	49
9 9 72	40.90	36.00	-4.90	1.6117	1.5563	-0.55405E-01	50
9 12 72	136.40	119.00	-17.40	2.1348	2.0755	-0.59262E-01	51
9 18 72	57.30	50.00	-7.30	1.7581	1.6990	-0.59161E-01	52
9 21 72	97.00	75.00	-22.00	1.9868	1.8751	-0.11171	53
9 24 72	83.40	102.00	18.60	1.9212	2.0086	0.87441E-01	54
MEAN	117.46	104.69				-0.44823E-01	

CORRELATION COEFFICIENT 0.638

COEFFICIENTS OF BEST FITTING STRAIGHT LINE --FIRST SET IS NOT FORCED THROUGH ORIGIN, SECOND SET IS FORCED

INTERCEPT	SLOPE	ERROR STD DEV
10.67	0.800	27.12
0.00	0.882	26.98

T VALUE FOR TEST OF BETA 1.3 DEGREES OF FREEDOM 52

ANALYSIS OF LOGS--

MEAN DIFFERENCE -0.44823E-01

T-STATISTIC -2.80

STD DEV 0.11768

DEGREES OF FREEDOM 53

TABLE V. - Continued. TOTAL SUSPENDED PARTICULATE (TSP) CONCENTRATIONS FOR GLASS FIBER AND WHATMAN-41 FILTERS

(f) Station 7

DATE	W41	GF	GF-W41	LOG (W41)	LOG (GF)	LOG (GF) - LOG (W41)	
8 10 71	132.00	120.00	-12.00	2.1206	2.0792	-0.41393E-01	1
8 16 71	65.00	85.00	20.00	1.8129	1.9294	0.11651	2
8 19 71	167.00	152.00	-15.00	2.2227	2.1818	-0.40873E-01	3
8 25 71	98.00	95.00	-3.00	1.9912	1.9777	-0.13503E-01	4
8 31 71	166.00	155.00	-11.00	2.2201	2.1903	-0.29777E-01	5
9 6 71	124.00	73.00	-51.00	2.0934	1.8633	-0.23010	6
9 12 71	54.00	29.00	-25.00	1.7324	1.4624	-0.27000	7
9 15 71	120.00	100.00	-20.00	2.0792	2.0000	-0.79181E-01	8
9 18 71	146.00	151.00	5.00	2.1644	2.1790	0.14625E-01	9
9 24 71	42.00	51.00	9.00	1.6232	1.7076	0.84321E-01	10
9 30 71	158.00	185.00	27.00	2.1987	2.2672	0.68515E-01	11
10 2 71	126.00	132.00	6.00	2.1004	2.1206	0.20204E-01	12
10 6 71	49.00	51.00	2.00	1.6902	1.7076	0.17374E-01	13
10 9 71	44.00	37.00	-7.00	1.6435	1.5682	-0.75252E-01	14
10 12 71	88.00	75.00	-13.00	1.9445	1.8751	-0.69422E-01	15
10 18 71	159.00	145.00	-14.00	2.2014	2.1614	-0.40029E-01	16
10 21 71	164.00	149.00	-15.00	2.2148	2.1732	-0.41657E-01	17
10 24 71	113.00	98.00	-15.00	2.0531	1.9912	-0.61852E-01	18
10 27 71	129.00	111.00	-18.00	2.1106	2.0453	-0.65268E-01	19
10 30 71	192.00	210.00	18.00	2.2833	2.3222	0.38918E-01	20
11 2 71	84.00	76.00	-8.00	1.9243	1.8808	-0.43466E-01	21
11 5 71	79.00	76.00	-3.00	1.8976	1.8808	-0.16813E-01	22
11 11 71	93.00	116.00	23.00	1.9685	2.0645	0.95975E-01	23
12 26 71	42.00	40.00	-2.00	1.6232	1.6021	-0.21190E-01	24
1 22 72	66.00	65.00	-1.00	1.8195	1.8129	-0.66309E-02	25
1 25 72	166.00	151.00	-15.00	2.2201	2.1790	-0.41131E-01	26
1 28 72	56.00	75.00	19.00	1.7482	1.8751	0.12687	27
2 3 72	62.00	55.00	-7.00	1.7924	1.7404	-0.52030E-01	28
2 6 72	41.50	37.00	-4.50	1.6180	1.5682	-0.49847E-01	29
2 9 72	117.80	116.00	-1.80	2.0711	2.0645	-0.66757E-02	30
2 12 72	164.40	176.00	11.60	2.2159	2.2455	0.29614E-01	31
2 15 72	51.20	47.00	-4.20	1.7093	1.6721	-0.37166E-01	32
2 21 72	123.10	103.00	-20.10	2.0902	2.0128	-0.77413E-01	33
2 24 72	73.50	69.00	-4.50	1.8663	1.8388	-0.27438E-01	34
2 27 72	105.20	90.00	-15.20	2.0220	1.9542	-0.67771E-01	35
3 1 72	93.20	68.00	-25.20	1.9694	1.8325	-0.13690	36
3 4 72	126.00	112.00	-14.00	2.1004	2.0492	-0.51152E-01	37
3 7 72	100.90	99.00	-1.90	2.0039	1.9956	-0.82493E-02	38
3 10 72	148.00	90.00	-58.00	2.1703	1.9542	-0.21602	39
3 16 72	88.40	85.00	-3.40	1.9464	1.9294	-0.17026E-01	40
3 19 72	87.50	86.00	-1.50	1.9420	1.9345	-0.75102E-02	41
3 22 72	50.50	46.00	-4.50	1.7033	1.6628	-0.40534E-01	42
3 25 72	35.90	41.00	5.10	1.5551	1.6128	0.57709E-01	43
3 28 72	77.90	85.00	7.10	1.8915	1.9294	0.37890E-01	44
4 3 72	111.50	106.00	-5.50	2.0473	2.0253	-0.21969E-01	45
4 6 72	109.20	105.00	-4.20	2.0382	2.0212	-0.17031E-01	46
4 9 72	91.60	81.00	-10.60	1.9619	1.9085	-0.53399E-01	47
4 12 72	179.10	175.00	-4.10	2.2531	2.2430	-0.10052E-01	48
4 15 72	101.80	107.00	5.20	2.0077	2.0294	0.21649E-01	49
4 18 72	115.60	114.00	-1.60	2.0629	2.0569	-0.60434E-02	50
4 21 72	127.40	117.00	-10.40	2.1052	2.0682	-0.36978E-01	51
4 27 72	76.70	73.00	-3.70	1.8848	1.8633	-0.21468E-01	52
4 30 72	130.10	131.00	0.90	2.1143	2.1173	0.30022E-02	53
5 3 72	95.40	92.00	-3.40	1.9795	1.9638	-0.15754E-01	54
5 24 72	158.10	163.00	4.90	2.1989	2.2122	0.13262E-01	55
5 27 72	139.70	132.00	-7.70	2.1452	2.1206	-0.24619E-01	56
6 2 72	121.50	98.00	-23.50	2.0846	1.9912	-0.93349E-01	57
6 8 72	133.20	131.00	-2.20	2.1245	2.1173	-0.72298E-02	58
6 11 72	56.80	67.00	10.20	1.7543	1.8261	0.71751E-01	59
6 14 72	81.20	61.00	-20.20	1.9096	1.7853	-0.12422	60
6 17 72	86.60	77.00	-9.60	1.9375	1.8865	-0.51015E-01	61
6 20 72	94.70	71.00	-23.70	1.9763	1.8513	-0.12509	62
6 26 72	70.00	91.00	21.00	1.8451	1.9590	0.11394	63
6 29 72	88.70	100.00	11.30	1.9479	2.0000	0.52080E-01	64
7 2 72	80.80	104.00	23.20	1.9074	2.0170	0.10964	65
7 8 72	60.90	118.00	57.10	1.7846	2.0719	0.28728	66
7 11 72	116.00	118.00	2.00	2.0645	2.0719	0.74234E-02	67
7 14 72	103.30	85.00	-18.30	2.0141	1.9294	-0.84668E-01	68
7 20 72	131.30	116.00	-15.30	2.1183	2.0645	-0.53796E-01	69
7 29 72	110.00	119.00	9.00	2.0414	2.0755	0.34154E-01	70
8 1 72	113.00	109.00	-4.00	2.0531	2.0374	-0.15652E-01	71
8 7 72	60.70	60.00	-0.70	1.7832	1.7782	-0.50316E-02	72
8 10 72	48.50	70.00	21.50	1.6857	1.8451	0.15936	73
8 16 72	132.40	101.00	-31.40	2.1219	2.0043	-0.11756	74
8 19 72	108.20	88.00	-20.20	2.0342	1.9445	-0.89741E-01	75
8 22 72	107.50	100.00	-7.50	2.0314	2.0000	-0.31408E-01	76
8 31 72	120.40	112.00	-8.40	2.0806	2.0492	-0.31403E-01	77
9 3 72	32.60	24.00	-8.60	1.5132	1.3802	-0.13298	78
9 6 72	107.00	94.00	-13.00	2.0294	1.9731	-0.56256E-01	79
9 9 72	21.60	27.00	5.40	1.3344	1.4314	0.96957E-01	80
9 12 72	152.70	150.00	-2.70	2.1838	2.1761	-0.77457E-02	81
9 18 72	41.50	53.00	11.50	1.6180	1.7243	0.10623	82
9 21 72	90.30	86.00	-4.30	1.9557	1.9345	-0.21174E-01	83
9 24 72	71.10	61.00	-10.10	1.8519	1.7853	-0.66525E-01	84
MEAN	100.57	96.37				-0.18097E-01	

CORRELATION COEFFICIENT 0.914

COEFFICIENTS OF BEST FITTING STRAIGHT LINE --FIRST SET IS NOT FORCED THROUGH ORIGIN, SECOND SET IS FORCED

INTERCEPT	SLOPE	ERROR STD DEV
-1.74	0.976	11.43
0.00	0.960	11.37

T VALUE FOR TEST OF BETA 0.51 DEGREES OF FREEDOM 82

ANALYSIS OF LOGS--

MEAN DIFFERENCE -0.18097E-01

T-STATISTIC -2.03

STD DEV 0.81722E-01

DEGREES OF FREEDOM 83

TABLE V. - Continued. TOTAL SUSPENDED PARTICULATE (TSP) CONCENTRATIONS FOR GLASS FIBER AND WHATMAN-41 FILTERS

(g) Station 8

DATE	W41	GF	GF-W41	LOG(W41)	LOG(GF)	LOG(GF)-LOG(W41)	
8 19 71	152.00	139.00	-13.00	2.1818	2.1430	-0.38829E-01	1
8 22 71	86.00	62.00	-24.00	1.9345	1.7924	-0.14211	2
8 25 71	81.00	78.00	-3.00	1.9085	1.8921	-0.16390E-01	3
9 6 71	112.00	79.00	-33.00	2.0492	1.8976	-0.15159	4
9 18 71	197.00	172.00	-25.00	2.2945	2.2355	-0.58938E-01	5
9 24 71	56.00	68.00	12.00	1.7482	1.8325	0.84320E-01	6
9 30 71	270.00	233.00	-37.00	2.4314	2.3674	-0.64008E-01	7
10 21 71	166.00	127.00	-39.00	2.2201	2.1038	-0.11630	8
10 27 71	112.00	91.00	-21.00	2.0492	1.9590	-0.90178E-01	9
10 30 71	236.00	205.00	-31.00	2.3729	2.3118	-0.61157E-01	10
11 2 71	72.00	68.00	-4.00	1.8573	1.8325	-0.24824E-01	11
11 5 71	69.00	68.00	-1.00	1.8388	1.8325	-0.63410E-02	12
11 11 71	75.00	107.00	32.00	1.8751	2.0294	0.15432	13
11 17 71	128.00	131.00	3.00	2.1072	2.1173	0.10062E-01	14
12 2 71	78.00	113.00	35.00	1.8921	2.0531	0.16098	15
12 8 71	55.00	72.00	17.00	1.7404	1.8573	0.11697	16
12 11 71	54.00	63.00	9.00	1.7324	1.7993	0.66947E-01	17
1 16 72	43.00	39.00	-4.00	1.6335	1.5911	-0.42403E-01	18
1 19 72	77.00	100.00	23.00	1.8865	2.0000	0.11351	19
1 22 72	80.00	60.00	-20.00	1.9031	1.7782	-0.12494	20
1 25 72	123.00	109.00	-14.00	2.0899	2.0374	-0.52479E-01	21
1 28 72	52.00	64.00	12.00	1.7160	1.8062	0.90178E-01	22
2 3 72	52.00	44.00	-8.00	1.7160	1.6435	-0.72550E-01	23
2 6 72	41.10	126.00	84.90	1.6138	2.1004	0.48655	24
2 9 72	161.90	39.00	-122.90	2.2092	1.5911	-0.61818	25
2 12 72	240.50	157.00	-83.50	2.3811	2.1959	-0.18522	26
2 15 72	50.80	35.00	-15.80	1.7058	1.5441	-0.16177	27
2 21 72	93.10	65.00	-28.10	1.9689	1.8129	-0.15602	28
2 24 72	103.00	84.00	-19.00	2.0128	1.9243	-0.88557E-01	29
2 27 72	86.30	66.00	-20.30	1.9360	1.8195	-0.11645	30
3 1 72	57.80	84.00	26.20	1.7619	1.9243	0.16238	31
3 4 72	105.70	85.00	-20.70	2.0241	1.9294	-0.94653E-01	32
3 7 72	80.50	79.00	-1.50	1.9058	1.8976	-0.81682E-02	33
3 10 72	115.70	95.00	-20.70	2.0633	1.9777	-0.85607E-01	34
3 16 72	94.70	78.00	-16.70	1.9763	1.8921	-0.84251E-01	35
3 19 72	90.00	98.00	8.00	1.9542	1.9912	0.36984E-01	36
3 22 72	37.50	31.00	-6.50	1.5740	1.4914	-0.82670E-01	37
3 25 72	35.40	38.00	2.60	1.5490	1.5798	0.30800E-01	38
3 28 72	143.40	167.00	23.60	2.1565	2.2227	0.66173E-01	39
4 3 72	112.90	96.00	-16.90	2.0527	1.9823	-0.70416E-01	40
4 6 72	79.30	126.00	46.70	1.8993	2.1004	0.20111	41
4 9 72	138.10	110.00	-28.10	2.1402	2.0414	-0.98794E-01	42
4 12 72	229.20	183.00	-46.20	2.3602	2.2625	-0.97761E-01	43
4 15 72	127.00	121.00	-6.00	2.1038	2.0828	-0.21018E-01	44
4 18 72	76.40	66.00	-10.40	1.8831	1.8195	-0.63540E-01	45
4 21 72	76.50	58.00	-18.50	1.8837	1.7634	-0.12023	46
4 27 72	158.10	156.00	-2.10	2.1989	2.1931	-0.58002E-02	47
4 30 72	147.00	116.00	-31.00	2.1673	2.0645	-0.10286	48
5 3 72	109.70	97.00	-12.70	2.0402	1.9868	-0.53432E-01	49
5 15 72	73.90	68.00	-5.90	1.8686	1.8325	-0.36127E-01	50
5 18 72	175.50	144.00	-31.50	2.2443	2.1584	-0.85915E-01	51
5 21 72	169.20	145.00	-24.20	2.2284	2.1614	-0.67030E-01	52
5 24 72	339.50	252.00	-87.50	2.5308	2.4014	-0.12944	53
5 27 72	177.60	133.00	-44.60	2.2494	2.1239	-0.12559	54
6 2 72	86.20	78.00	-8.20	1.9355	1.8921	-0.43406E-01	55
6 8 72	154.90	106.00	-48.90	2.1900	2.0253	-0.16474	56
6 11 72	22.70	64.00	41.30	1.3560	1.8062	0.45017	57
6 14 72	69.90	58.00	-11.90	1.8445	1.7634	-0.81039E-01	58
6 17 72	110.60	93.00	-17.60	2.0437	1.9685	-0.75263E-01	59
6 20 72	69.60	113.00	43.40	1.8426	2.0531	0.21048	60
6 26 72	62.60	54.00	-8.60	1.7966	1.7324	-0.64164E-01	61
6 29 72	101.00	100.00	-1.00	2.0043	2.0000	-0.43211E-02	62
7 2 72	64.60	33.00	-31.60	1.8102	1.5185	-0.29170	63
7 8 72	64.40	80.00	15.60	1.8089	1.9031	0.94214E-01	64
7 11 72	109.70	103.00	-6.70	2.0402	2.0128	-0.27367E-01	65
7 14 72	87.80	76.00	-11.80	1.9435	1.8808	-0.62665E-01	66
7 20 72	134.60	412.00	277.40	2.1290	2.6149	0.48586	67
7 29 72	96.00	89.00	-7.00	1.9823	1.9494	-0.32882E-01	68
8 1 72	106.10	99.00	-7.10	2.0257	1.9956	-0.30070E-01	69
8 25 72	81.30	94.00	12.70	1.9101	1.9731	0.63054E-01	70
9 6 72	72.40	72.00	-0.40	1.8597	1.8573	-0.23966E-02	71
9 9 72	31.00	36.00	5.00	1.4914	1.5563	0.64941E-01	72
9 18 72	40.90	53.00	12.10	1.6117	1.7243	0.11257	73
9 21 72	68.70	75.00	6.30	1.8370	1.8751	0.38110E-01	74
9 24 72	53.90	48.00	-5.90	1.7316	1.6812	-0.50335E-01	75

MEAN 104.56 99.01 -0.19363E-01

CORRELATION COEFFICIENT 0.709

COEFFICIENTS OF BEST FITTING STRAIGHT LINE --FIRST SET IS NOT FORCED THROUGH ORIGIN, SECOND SET IS FORCED

INTERCEPT	SLOPE	ERROR STD DEV
-3.36	0.979	31.60
0.00	0.953	31.41

T VALUE FOR TEST OF BETA 0.16 DEGREES OF FREEDOM 73

ANALYSIS OF LOGS--

MEAN DIFFERENCE -0.19363E-01

T-STATISTIC -1.09

STD DEV 0.15410

DEGREES OF FREEDOM 74

TABLE V. - Continued. TOTAL SUSPENDED PARTICULATE (TSP) CONCENTRATIONS FOR GLASS FIBER AND WHATMAN-41 FILTERS

(h) Station 9

DATE	W41	GF	GF-W41	LOG (W41)	LOG (GF)	LOG (GF) - LOG (W41)	
8 16 71	122.00	128.00	6.00	2.0864	2.1072	0.20850E-01	1
8 28 71	133.00	122.00	-11.00	2.1239	2.0864	-0.37493E-01	2
8 31 71	133.00	149.00	16.00	2.1239	2.1732	0.49335E-01	3
9 6 71	156.00	150.00	-6.00	2.1931	2.1761	-0.17034E-01	4
9 15 71	157.00	156.00	-1.00	2.1959	2.1931	-0.27742E-02	5
9 18 71	55.00	71.00	16.00	1.7404	1.8513	0.11090	6
9 21 71	149.00	213.00	64.00	2.1732	2.3284	0.15519	7
9 24 71	60.00	108.00	48.00	1.7782	2.0334	0.25527	8
9 30 71	140.00	190.00	50.00	2.1461	2.2788	0.13263	9
10 2 71	158.00	184.00	26.00	2.1987	2.2648	0.66160E-01	10
10 6 71	221.00	273.00	52.00	2.3444	2.4362	0.91771E-01	11
10 9 71	86.00	75.00	-11.00	1.9345	1.8751	-0.59437E-01	12
10 12 71	218.00	214.00	-4.00	2.3385	2.3304	-0.80423E-02	13
10 18 71	143.00	161.00	18.00	2.1553	2.2068	0.51491E-01	14
10 21 71	130.00	134.00	4.00	2.1139	2.1271	0.13162E-01	15
10 27 71	167.00	197.00	30.00	2.2227	2.2945	0.71750E-01	16
10 30 71	170.00	183.00	13.00	2.2304	2.2625	0.32002E-01	17
11 2 71	204.00	366.00	162.00	2.3096	2.5635	0.25385	18
11 14 71	93.00	138.00	45.00	1.9685	2.1399	0.17140	19
12 2 71	196.00	277.00	81.00	2.2923	2.4425	0.15022	20
12 8 71	99.00	152.00	53.00	1.9956	2.1818	0.18621	21
12 14 71	87.00	115.00	28.00	1.9395	2.0607	0.12118	22
12 20 71	101.00	213.00	112.00	2.0043	2.3284	0.32406	23
12 26 71	75.00	141.00	66.00	1.8751	2.1492	0.27416	24
1 13 72	92.00	129.00	37.00	1.9638	2.1106	0.14680	25
1 16 72	85.00	145.00	60.00	1.9294	2.1614	0.23195	26
1 19 72	140.00	260.00	120.00	2.1461	2.4150	0.26885	27
1 22 72	79.00	119.00	40.00	1.8976	2.0755	0.17792	28
1 25 72	239.00	421.00	182.00	2.3784	2.6243	0.24588	29
1 28 72	154.00	258.00	104.00	2.1875	2.4116	0.22410	30
2 12 72	119.20	244.00	124.80	2.0763	2.3874	0.31112	31
2 15 72	182.90	286.00	103.10	2.2622	2.4564	0.19416	32
2 21 72	164.40	281.00	116.60	2.2159	2.4487	0.23281	33
2 24 72	170.60	224.00	53.40	2.2320	2.3502	0.11827	34
2 27 72	125.10	169.00	43.90	2.0972	2.2279	0.13064	35
3 1 72	141.50	181.00	39.50	2.1508	2.2577	0.10692	36
3 4 72	105.10	164.00	58.90	2.0216	2.2148	0.19325	37
3 7 72	198.70	346.00	147.30	2.2982	2.5391	0.24088	38
3 10 72	84.40	114.00	29.60	1.9263	2.0569	0.13057	39
4 6 72	99.20	271.00	171.80	1.9965	2.4330	0.43646	40
4 12 72	108.60	237.00	128.40	2.0358	2.3747	0.33893	41
4 15 72	91.00	238.00	147.00	1.9590	2.3766	0.41754	42
4 18 72	123.70	276.00	152.30	2.0924	2.4409	0.34854	43
4 21 72	81.20	158.00	76.80	1.9096	2.1987	0.28911	44
4 27 72	79.60	183.00	103.40	1.9009	2.2625	0.36155	45
4 30 72	75.60	153.00	77.40	1.8785	2.1847	0.30618	46
5 6 72	184.90	359.00	174.10	2.2669	2.5551	0.28816	47
5 15 72	138.10	289.00	150.90	2.1402	2.4609	0.32071	48
5 18 72	140.80	358.00	217.20	2.1486	2.5539	0.40529	49
5 21 72	106.70	223.00	116.30	2.0282	2.3483	0.32014	50
5 24 72	110.20	296.00	185.80	2.0422	2.4713	0.42911	51
5 27 72	13.60	268.00	254.40	1.1335	2.4281	1.2946	52
6 2 72	230.20	528.00	297.80	2.3621	2.7226	0.36053	53
6 11 72	75.50	171.00	95.50	1.8779	2.2330	0.35505	54
6 14 72	113.30	225.00	111.70	2.0542	2.3522	0.29797	55
6 20 72	123.20	208.00	84.80	2.0906	2.3181	0.22746	56
6 26 72	141.70	248.00	106.30	2.1514	2.3945	0.24308	57
7 2 72	82.70	193.00	110.30	1.9175	2.2856	0.36806	58
7 8 72	85.50	199.00	113.50	1.9320	2.2989	0.36689	59
7 11 72	129.90	281.00	151.10	2.1136	2.4487	0.33510	60
7 14 72	224.10	331.00	106.90	2.3504	2.5198	0.16939	61
7 20 72	177.00	273.00	96.00	2.2480	2.4362	0.18819	62
7 29 72	54.50	62.00	7.50	1.7364	1.7924	0.55996E-01	63
8 1 72	115.70	250.00	134.30	2.0633	2.3979	0.33461	64
8 10 72	56.10	149.00	92.90	1.7489	2.1732	0.42424	65
8 16 72	125.80	195.00	69.20	2.0997	2.2900	0.19036	66
8 19 72	80.40	98.00	17.60	1.9052	1.9912	0.85979E-01	67
8 22 72	96.10	157.00	60.90	1.9827	2.1959	0.21319	68
8 25 72	107.50	214.00	106.50	2.0314	2.3304	0.29901	69
8 31 72	106.30	190.00	83.70	2.0265	2.2788	0.25223	70
9 3 72	35.40	47.00	11.60	1.5490	1.6721	0.12311	71
9 6 72	89.90	178.00	88.10	1.9538	2.2504	0.29667	72
9 12 72	97.50	169.00	71.50	1.9890	2.2279	0.23686	73
9 18 72	97.80	158.00	60.20	1.9903	2.1987	0.20833	74
9 21 72	76.30	123.00	46.70	1.8825	2.0899	0.20740	75
9 24 72	141.80	210.00	68.20	2.1517	2.3222	0.17055	76
MEAN	123.04	205.49				0.22276	

CORRELATION COEFFICIENT 0.689

COEFFICIENTS OF BEST FITTING STRAIGHT LINE --FIRST SET IS NOT FORCED THROUGH ORIGIN, SECOND SET IS FORCED

INTERCEPT	SLOPE	ERROR STD DEV
-67.85	2.222	32.02
0.00	1.721	33.17

T VALUE FOR TEST OF BETA 7.2 DEGREES OF FREEDOM 74

ANALYSIS OF LOGS--
MEAN DIFFERENCE 0.22276
T-STATISTIC 11.10
STD DEV 0.17491
DEGREES OF FREEDOM 75

TABLE V. - Continued. TOTAL SUSPENDED PARTICULATE (TSP) CONCENTRATIONS FOR GLASS FIBER AND WHATMAN-41 FILTERS

(i) Station 10

DATE	W41	GF	GF-W41	LOG (W41)	LOG (GF)	LOG (GF) - LOG (W41)	
8 10 71	288.00	279.00	-9.00	2.4594	2.4456	-0.13768E-01	1
8 22 71	150.00	147.00	-3.00	2.1761	2.1673	-0.87738E-02	2
8 25 71	201.00	211.00	10.00	2.3032	2.3243	0.21087E-01	3
8 28 71	245.00	166.00	-79.00	2.3892	2.2201	-0.16906	4
9 6 71	184.00	134.00	-50.00	2.2648	2.1271	-0.13771	5
9 9 71	135.00	108.00	-27.00	2.1303	2.0334	-0.96910E-01	6
9 15 71	164.00	160.00	-4.00	2.2148	2.2041	-0.10724E-01	7
9 18 71	109.00	101.00	-8.00	2.0374	2.0043	-0.33105E-01	8
9 24 71	64.00	27.00	-37.00	1.8062	1.4314	-0.37482	9
9 30 71	136.00	151.00	15.00	2.1335	2.1790	0.45439E-01	10
10 2 71	118.00	127.00	9.00	2.0719	2.1038	0.31922E-01	11
10 6 71	434.00	399.00	-35.00	2.6375	2.6010	-0.36517E-01	12
10 9 71	89.00	74.00	-15.00	1.9494	1.8692	-0.80158E-01	13
10 12 71	190.00	170.00	-20.00	2.2788	2.2304	-0.48305E-01	14
10 18 71	162.00	129.00	-33.00	2.2095	2.1106	-0.98925E-01	15
10 21 71	178.00	169.00	-9.00	2.2504	2.2279	-0.22533E-01	16
10 24 71	71.00	60.00	-11.00	1.8513	1.7782	-0.73108E-01	17
10 27 71	163.00	161.00	-2.00	2.2122	2.2068	-0.53606E-02	18
10 30 71	197.00	231.00	34.00	2.2945	2.3636	0.69146E-01	19
11 2 71	195.00	152.00	-43.00	2.2900	2.1818	-0.10819	20
11 14 71	81.00	113.00	32.00	1.9085	2.0531	0.14459	21
11 17 71	161.00	194.00	33.00	2.2068	2.2878	0.80976E-01	22
12 2 71	196.00	186.00	-10.00	2.2923	2.2695	-0.22742E-01	23
12 11 71	88.00	89.00	1.00	1.9445	1.9494	0.49067E-02	24
12 20 71	98.00	137.00	39.00	1.9912	2.1367	0.14549	25
12 26 71	87.00	72.00	-15.00	1.9395	1.8573	-0.82187E-01	26
1 7 72	142.00	159.00	17.00	2.1523	2.2014	0.49109E-01	27
1 13 72	74.00	104.00	30.00	1.8692	2.0170	0.14780	28
1 16 72	86.00	88.00	2.00	1.9345	1.9445	0.99850E-02	29
1 19 72	136.00	143.00	7.00	2.1335	2.1553	0.21797E-01	30
1 25 72	224.00	211.00	-13.00	2.3502	2.3243	-0.25965E-01	31
2 3 72	104.30	93.00	-11.30	2.0183	1.9685	-0.49788E-01	32
2 15 72	213.00	247.00	34.00	2.3284	2.3927	0.64317E-01	33
2 21 72	309.19	331.00	21.81	2.4902	2.5198	0.29606E-01	34
3 10 72	84.10	92.00	7.90	1.9248	1.9638	0.39003E-01	35
3 16 72	97.50	102.00	4.50	1.9890	2.0086	0.19595E-01	36
3 22 72	80.70	71.00	-9.70	1.9069	1.8513	-0.55611E-01	37
3 29 72	115.00	130.00	15.00	2.0607	2.1139	0.53246E-01	38
4 3 72	132.00	149.00	17.00	2.1206	2.1732	0.52612E-01	39
4 6 72	177.00	198.00	21.00	2.2480	2.2967	0.48693E-01	40
4 12 72	247.00	277.00	30.00	2.3927	2.4425	0.49783E-01	41
4 15 72	156.70	212.00	55.30	2.1951	2.3263	0.13127	42
4 18 72	164.40	198.00	33.60	2.2159	2.2967	0.80768E-01	43
4 21 72	110.70	102.00	-8.70	2.0441	2.0086	-0.35545E-01	44
4 27 72	87.20	100.00	12.80	1.9405	2.0000	0.59488E-01	45
4 30 72	146.60	136.00	-10.60	2.1661	2.1335	-0.32569E-01	46
5 3 72	193.90	198.00	4.10	2.2876	2.2967	0.90914E-02	47
5 6 72	200.00	192.00	-8.00	2.3010	2.2833	-0.17729E-01	48
5 9 72	123.20	106.00	-17.20	2.0906	2.0253	-0.65302E-01	49
5 15 72	147.50	146.00	-1.90	2.1700	2.1644	-0.56105E-02	50
5 18 72	179.60	196.00	16.40	2.2543	2.2923	0.37955E-01	51
5 21 72	174.50	57.00	-117.50	2.2418	1.7559	-0.48592	52
5 24 72	258.06	275.00	16.94	2.4117	2.4393	0.27607E-01	53
5 27 72	171.60	184.00	12.40	2.2345	2.2648	0.30307E-01	54
6 2 72	163.80	181.00	17.20	2.2143	2.2577	0.43373E-01	55
6 8 72	274.75	286.00	11.25	2.4389	2.4564	0.17428E-01	56
6 11 72	127.90	100.00	-27.90	2.1069	2.0000	-0.10686	57
6 14 72	186.30	213.00	26.70	2.2702	2.3284	0.58174E-01	58
6 20 72	159.00	138.00	-21.00	2.2014	2.1399	-0.61518E-01	59
6 26 72	122.40	159.00	36.60	2.0878	2.2014	0.11362	60
6 29 72	96.60	137.00	40.40	1.9850	2.1367	0.15175	61
7 2 72	104.70	162.00	57.30	2.0199	2.2095	0.18957	62
7 8 72	82.20	138.00	55.80	1.9149	2.1399	0.22501	63
7 11 72	182.30	197.00	14.70	2.2608	2.2945	0.33687E-01	64
7 14 72	169.30	188.00	18.70	2.2286	2.2742	0.45509E-01	65
7 20 72	196.80	198.00	1.20	2.2940	2.2967	0.26474E-02	66
8 1 72	152.50	207.00	54.50	2.1833	2.3160	0.13270	67
8 10 72	116.20	188.00	71.80	2.0652	2.2742	0.20895	68
8 13 72	158.00	204.00	46.00	2.1987	2.3096	0.11097	69
8 25 72	97.40	113.00	15.60	1.9886	2.0531	0.64527E-01	70
9 18 72	5.40	91.00	85.60	0.73239	1.9590	1.2267	71
9 21 72	98.40	113.00	14.60	1.9930	2.0531	0.60090E-01	72
9 24 72	127.70	124.00	-3.70	2.1062	2.0934	-0.12766E-01	73
MEAN	152.63	158.64				0.24824E-01	

CORRELATION COEFFICIENT 0.881

COEFFICIENTS OF BEST FITTING STRAIGHT LINE --FIRST SET IS NOT FORCED THROUGH ORIGIN, SECOND SET IS FORCED

INTERCEPT	SLOPE	ERROR STD DEV
6.11	0.999	22.81
0.00	1.034	22.70

T VALUE FOR TEST OF BETA 0.31E-02 DEGREES OF FREEDOM 71

ANALYSIS OF LOGS--

MEAN DIFFERENCE 0.24824E-01

T-STATISTIC 1.18

STD DEV 0.17913

DEGREES OF FREEDOM 72

TABLE V. - Continued. TOTAL SUSPENDED PARTICULATE (TSP) CONCENTRATIONS FOR GLASS FIBER AND WHATMAN-41 FILTERS

(j) Station 12

DATE	W41	GF	GF-W41	LOG(W41)	LOG(GF)	LOG(GF)-LOG(W41)	
8 10 71	152.00	164.00	12.00	2.1818	2.2148	0.33000E-01	1
8 22 71	70.00	68.00	-2.00	1.8451	1.8325	-0.12589E-01	2
8 25 71	92.00	88.00	-4.00	1.9638	1.9445	-0.19304E-01	3
8 28 71	69.00	95.00	26.00	1.8388	1.9777	0.13887	4
8 31 71	152.00	148.00	-4.00	2.1818	2.1703	-0.11582E-01	5
9 6 71	116.00	87.00	-29.00	2.0645	1.9395	-0.12494	6
9 12 71	58.00	27.00	-31.00	1.7634	1.4314	-0.33206	7
9 15 71	106.00	110.00	4.00	2.0253	2.0414	0.16087E-01	8
9 18 71	92.00	100.00	8.00	1.9638	2.0000	0.36213E-01	9
9 21 71	41.00	51.00	10.00	1.6128	1.7076	0.94787E-01	10
9 30 71	93.00	167.00	74.00	1.9685	2.2227	0.25423	11
10 2 71	73.00	105.00	32.00	1.8633	2.0212	0.15787	12
10 6 71	26.00	41.00	15.00	1.4150	1.6128	0.19781	13
10 9 71	40.00	43.00	3.00	1.6021	1.6335	0.31406E-01	14
10 12 71	51.00	58.00	7.00	1.7076	1.7634	0.55658E-01	15
10 18 71	114.00	140.00	26.00	2.0569	2.1461	0.89223E-01	16
10 21 71	96.00	123.00	27.00	1.9823	2.0899	0.10763	17
10 24 71	79.00	84.00	5.00	1.8976	1.9243	0.26652E-01	18
10 27 71	93.00	115.00	22.00	1.9685	2.0607	0.92215E-01	19
10 30 71	112.00	169.00	57.00	2.0492	2.2279	0.17867	20
11 2 71	59.00	69.00	10.00	1.7709	1.8388	0.67997E-01	21
11 11 71	69.00	103.00	34.00	1.8388	2.0128	0.17399	22
11 17 71	101.00	136.00	35.00	2.0043	2.1335	0.12922	23
12 5 71	94.00	103.00	9.00	1.9731	2.0128	0.39709E-01	24
12 8 71	33.00	59.00	26.00	1.5185	1.7709	0.25234	25
12 11 71	48.00	69.00	21.00	1.6812	1.8388	0.15761	26
12 20 71	49.00	76.00	27.00	1.6902	1.8808	0.19062	27
12 26 71	32.00	33.00	1.00	1.5051	1.5185	0.13364E-01	28
3 19 72	73.80	96.00	22.20	1.8680	1.9823	0.11423	29
3 22 72	40.40	47.00	6.60	1.6064	1.6721	0.65733E-01	30
3 25 72	13.70	25.00	11.30	1.1367	1.3979	0.26122	31
3 28 72	42.90	62.00	19.10	1.6324	1.7924	0.15995	32
4 3 72	84.60	96.00	11.40	1.9274	1.9823	0.54914E-01	33
4 6 72	73.80	93.00	19.20	1.8680	1.9685	0.10045	34
4 9 72	72.40	69.00	-3.40	1.8597	1.8388	-0.20880E-01	35
4 12 72	65.50	148.00	82.50	1.8162	2.1703	0.35402	36
4 15 72	77.00	101.00	24.00	1.8865	2.0043	0.11783	37
4 18 72	51.20	99.00	47.80	1.7093	1.9956	0.28637	38
4 21 72	76.60	89.00	12.40	1.8842	1.9494	0.65174E-01	39
4 27 72	38.60	46.00	7.40	1.5866	1.6628	0.76197E-01	40
4 30 72	91.60	97.00	5.40	1.9619	1.9868	0.24888E-01	41
5 3 72	71.20	82.00	10.80	1.8525	1.9138	0.61338E-01	42
5 6 72	108.40	113.00	4.60	2.0350	2.0531	0.18055E-01	43
5 9 72	55.50	36.00	-19.50	1.7443	1.5563	-0.18799	44
5 15 72	67.70	72.00	4.30	1.8306	1.8573	0.26749E-01	45
5 18 72	97.90	124.00	26.10	1.9908	2.0934	0.10265	46
5 21 72	102.40	109.00	6.60	2.0103	2.0374	0.27133E-01	47
5 24 72	99.10	143.00	43.90	1.9961	2.1553	0.15927	48
5 27 72	106.80	123.00	16.20	2.0286	2.0899	0.61346E-01	49
6 2 72	84.90	88.00	3.10	1.9289	1.9445	0.15583E-01	50
6 8 72	87.00	95.00	8.00	1.9395	1.9777	0.38204E-01	51
6 11 72	38.50	53.00	14.50	1.5855	1.7243	0.13882	52
6 17 72	60.30	52.00	-8.30	1.7803	1.7160	-0.64292E-01	53
6 20 72	57.50	66.00	8.50	1.7597	1.8195	0.59876E-01	54
6 29 72	43.80	75.00	31.20	1.6414	1.8751	0.23362	55
7 2 72	54.50	86.00	31.50	1.7364	1.9345	0.19810	56
7 11 72	79.70	95.00	15.30	1.9015	1.9777	0.76269E-01	57
7 14 72	89.50	89.00	-0.50	1.9518	1.9494	-0.24338E-02	58
7 20 72	113.80	112.00	-1.80	2.0561	2.0492	-0.69122E-02	59
7 29 72	79.90	112.00	32.10	1.9025	2.0492	0.14668	60
8 1 72	84.40	94.00	9.60	1.9263	1.9731	0.46793E-01	61
8 10 72	34.40	61.00	26.60	1.5365	1.7853	0.24879	62
8 13 72	90.60	126.00	35.40	1.9571	2.1004	0.14325	63
8 16 72	88.00	89.00	1.00	1.9445	1.9494	0.49067E-02	64
8 19 72	89.10	68.00	-21.10	1.9499	1.8325	-0.11736	65
8 22 72	58.80	70.00	11.20	1.7694	1.8451	0.75744E-01	66
9 3 72	29.10	19.00	-10.10	1.4639	1.2788	-0.18510	67
9 6 72	69.00	75.00	6.00	1.8388	1.8751	0.36212E-01	68
9 18 72	37.60	53.00	15.40	1.5752	1.7243	0.14912	69
9 21 72	59.60	75.00	15.40	1.7752	1.8751	0.99833E-01	70
9 24 72	67.20	65.00	-2.20	1.8274	1.8129	-0.14451E-01	71

MEAN 73.50 87.59 0.74434E-01

CORRELATION COEFFICIENT 0.821

COEFFICIENTS OF BEST FITTING STRAIGHT LINE --FIRST SET IS NOT FORCED THROUGH ORIGIN, SECOND SET IS FORCED

INTERCEPT	SLOPE	ERROR STD DEV
-5.83	1.271	13.10
0.00	1.200	13.06

T VALUE FOR TEST OF BETA 2.9 DEGREES OF FREEDOM 69

ANALYSIS OF LOGS--

MEAN DIFFERENCE 0.74434E-01

T-STATISTIC 5.55

STD DEV 0.11307

DEGREES OF FREEDOM 70

TABLE V. - Continued. TOTAL SUSPENDED PARTICULATE (TSP) CONCENTRATIONS FOR GLASS FIBER AND WHATMAN-41 FILTERS

(k) Station 13

DATE	W41	GF	GF-W41	LOG(W41)	LOG(GF)	LOG(GF)-LOG(W41)	
8 10 71	122.00	206.00	84.00	2.0864	2.3139	0.22751	1
8 18 71	209.00	430.00	221.00	2.3201	2.6335	0.31332	2
8 22 71	82.00	95.00	13.00	1.9138	1.9777	0.63510E-01	3
8 25 71	132.00	214.00	82.00	2.1206	2.3304	0.20984	4
8 28 71	105.00	104.00	-1.00	2.0212	2.0170	-0.41552E-02	5
8 31 71	126.00	179.00	53.00	2.1004	2.2529	0.15248	6
9 6 71	78.00	110.00	32.00	1.8921	2.0414	0.14930	7
11 17 71	162.00	307.00	145.00	2.2095	2.4871	0.27762	8
12 29 71	72.00	201.00	129.00	1.8573	2.3032	0.44586	9
1 4 72	89.00	12.00	-77.00	1.9494	1.0792	-0.87021	10
1 13 72	475.00	162.00	-313.00	2.6767	2.2095	-0.46718	11
1 19 72	241.00	235.00	-6.00	2.3820	2.3711	-0.10949E-01	12
1 25 72	895.00	392.00	-503.00	2.9518	2.5933	-0.35854	13
1 28 72	96.00	188.00	92.00	1.9823	2.2742	0.29189	14
2 3 72	165.00	160.00	-5.00	2.2175	2.2041	-0.13364E-01	15
3 1 72	257.88	161.00	-96.88	2.4114	2.2068	-0.20458	16
3 4 72	94.60	152.00	57.40	1.9759	2.1818	0.20596	17
3 7 72	361.38	334.00	-27.38	2.5580	2.5237	-0.34211E-01	18
3 10 72	135.80	215.00	79.20	2.1329	2.3324	0.19955	19
3 16 72	145.80	132.00	-13.80	2.1637	2.1206	-0.43174E-01	20
3 19 72	75.20	109.00	33.80	1.8762	2.0374	0.16121	21
4 30 72	105.20	113.00	7.80	2.0220	2.0531	0.31065E-01	22
5 6 72	171.40	218.00	46.60	2.2340	2.3385	0.10445	23
5 9 72	62.70	116.00	53.30	1.7973	2.0645	0.26720	24
5 15 72	104.30	145.00	40.70	2.0183	2.1614	0.14310	25
5 18 72	143.90	348.00	204.10	2.1581	2.5416	0.38352	26
5 21 72	182.10	278.00	95.90	2.2603	2.4440	0.18374	27
5 24 72	171.20	311.00	139.80	2.2335	2.4928	0.25926	28
5 27 72	248.30	341.00	92.70	2.3950	2.5328	0.13778	29
6 2 72	187.00	226.00	39.00	2.2718	2.3541	0.82267E-01	30
6 8 72	226.50	279.00	52.50	2.3551	2.4456	0.90536E-01	31
6 14 72	127.60	179.00	51.40	2.1058	2.2529	0.14701	32
6 17 72	83.30	104.00	20.70	1.9206	2.0170	0.96405E-01	33
6 29 72	416.69	187.00	-229.69	2.6198	2.2718	-0.34797	34
7 2 72	64.20	131.00	66.80	1.8075	2.1173	0.30974	35
7 8 72	79.60	142.00	62.40	1.9009	2.1523	0.25139	36
7 14 72	92.00	147.00	55.00	1.9638	2.1673	0.20353	37
7 20 72	237.70	230.00	-7.70	2.3760	2.3617	-0.14300E-01	38
7 29 72	51.70	110.00	58.30	1.7135	2.0414	0.32791	39
8 1 72	196.00	232.00	36.00	2.2923	2.3655	0.73233E-01	40
8 7 72	107.00	125.00	18.00	2.0294	2.0969	0.67526E-01	41
8 10 72	109.10	161.00	51.90	2.0378	2.2068	0.16901	42
9 3 72	49.20	42.00	-7.20	1.6920	1.6232	-0.68708E-01	43
9 9 72	95.30	86.00	-9.30	1.9791	1.9345	-0.44580E-01	44
9 12 72	245.70	221.00	-24.70	2.3904	2.3444	-0.46012E-01	45
9 18 72	136.50	126.00	-10.50	2.1351	2.1004	-0.34762E-01	46
9 21 72	282.88	187.00	-95.88	2.4516	2.2718	-0.17975	47
9 24 72	100.80	86.00	-14.80	2.0034	1.9345	-0.68949E-01	48
MEAN	170.78	186.85				0.66994E-01	

CORRELATION COEFFICIENT 0.552

COEFFICIENTS OF BEST FITTING STRAIGHT LINE --FIRST SET IS NOT FORCED THROUGH ORIGIN, SECOND SET IS FORCED

INTERCEPT	SLOPE	ERROR STD DEV
107.74	0.463	69.95
0.00	0.928	83.51

T VALUE FOR TEST OF BETA 3.8 DEGREES OF FREEDOM 46

ANALYSIS OF LOGS--

MEAN DIFFERENCE 0.66994E-01

T-STATISTIC 1.98

STD DEV 0.23422

DEGREES OF FREEDOM 47

TABLE V. - Continued. TOTAL SUSPENDED PARTICULATE (TSP) CONCENTRATIONS FOR GLASS FIBER AND WHATMAN-41 FILTERS

(1) Station 14

DATE	W41	GF	GF-W41	LOG (W41)	LOG (GF)	LOG(GF)-LOG(W41)	
8 16 71	30.00	52.00	22.00	1.4771	1.7160	0.23888	1
8 25 71	108.00	116.00	8.00	2.0334	2.0645	0.31034E-01	2
8 28 71	66.00	75.00	9.00	1.8195	1.8751	0.55517E-01	3
9 15 71	157.00	110.00	-47.00	2.1959	2.0414	-0.15451	4
9 24 71	40.00	53.00	13.00	1.6021	1.7243	0.12222	5
9 30 71	32.00	59.00	27.00	1.5051	1.7709	0.26570	6
10 2 71	82.00	85.00	3.00	1.9138	1.9294	0.15605E-01	7
10 12 71	87.00	72.00	-15.00	1.9395	1.8573	-0.82187E-01	8
2 3 72	41.30	67.00	25.70	1.6159	1.8261	0.21016	9
2 15 72	49.30	49.00	-0.30	1.6928	1.6902	-0.26226E-02	10
2 21 72	77.80	55.00	-22.80	1.8910	1.7404	-0.15060	11
2 24 72	62.50	58.00	-4.50	1.7959	1.7634	-0.32452E-01	12
2 27 72	75.00	70.00	-5.00	1.8751	1.8451	-0.29963E-01	13
3 1 72	55.50	42.00	-13.50	1.7443	1.6232	-0.12104	14
3 4 72	81.90	80.00	-1.90	1.9133	1.9031	-0.10185E-01	15
3 7 72	67.20	25.00	-42.20	1.8274	1.3979	-0.42942	16
3 25 72	43.20	45.00	1.80	1.6355	1.6532	0.17737E-01	17
3 28 72	57.00	73.00	16.00	1.7559	1.8633	0.10745	18
4 12 72	127.70	189.00	61.30	2.1062	2.2765	0.17027	19
4 15 72	66.60	120.00	53.40	1.8235	2.0792	0.25572	20
4 18 72	77.50	97.00	19.50	1.8893	1.9868	0.97470E-01	21
4 27 72	58.50	80.00	21.50	1.7672	1.9031	0.13593	22
4 30 72	76.80	91.00	14.20	1.8853	1.9590	0.73697E-01	23
5 6 72	105.80	126.00	20.20	2.0245	2.1004	0.75898E-01	24
5 15 72	64.20	85.00	20.80	1.8075	1.9294	0.12189	25
5 18 72	127.20	144.00	16.80	2.1045	2.1584	0.53878E-01	26
5 21 72	103.00	107.00	4.00	2.0128	2.0294	0.16547E-01	27
5 27 72	108.80	119.00	10.20	2.0366	2.0755	0.38930E-01	28
6 2 72	96.40	106.00	9.60	1.9841	2.0253	0.41236E-01	29
6 11 72	55.80	71.00	15.20	1.7466	1.8513	0.10465	30
6 14 72	71.00	68.00	-3.00	1.8513	1.8325	-0.18750E-01	31
6 17 72	73.00	63.00	-10.00	1.8633	1.7993	-0.63982E-01	32
6 20 72	87.80	70.00	-17.80	1.9435	1.8451	-0.98381E-01	33
6 26 72	117.00	145.00	28.00	2.0682	2.1614	0.93183E-01	34
6 29 72	58.30	76.00	17.70	1.7656	1.8808	0.11517	35
7 2 72	72.60	94.00	21.40	1.8609	1.9731	0.11221	36
7 8 72	67.50	87.00	19.50	1.8293	1.9395	0.11022	37
7 11 72	177.60	89.00	-88.60	2.2494	1.9494	-0.30005	38
7 14 72	85.80	84.00	-1.80	1.9335	1.9243	-0.91915E-02	39
7 20 72	128.10	105.00	-23.10	2.1075	2.0212	-0.86352E-01	40
7 29 72	50.70	64.00	13.30	1.7050	1.8062	0.10118	41
8 1 72	96.60	101.00	4.40	1.9850	2.0043	0.19355E-01	42
8 7 72	48.60	56.00	7.40	1.6866	1.7482	0.61573E-01	43
8 10 72	41.80	66.00	24.20	1.6211	1.8195	0.19640	44
8 13 72	84.40	100.00	15.60	1.9263	2.0000	0.73666E-01	45
8 16 72	92.00	74.00	-18.00	1.9638	1.8692	-0.94556E-01	46
8 25 72	58.20	82.00	23.80	1.7649	1.9138	0.14690	47
9 6 72	134.10	110.00	-24.10	2.1274	2.0414	-0.86028E-01	48
9 12 72	98.00	121.00	23.00	1.9912	2.0828	0.91559E-01	49
9 18 72	39.60	56.00	16.40	1.5977	1.7482	0.15052	50
9 21 72	70.00	76.00	6.00	1.8451	1.8808	0.35716E-01	51
MEAN	79.09	84.47				0.35133E-01	

CORRELATION COEFFICIENT 0.695

COEFFICIENTS OF BEST FITTING STRAIGHT LINE --FIRST SET IS NOT FORCED THROUGH ORIGIN, SECOND SET IS FORCED

INTERCEPT	SLOPE	ERROR STD DEV
11.19	0.926	17.23
0.00	1.055	17.24

T VALUE FOR TEST OF BETA 0.52 DEGREES OF FREEDOM 49

ANALYSIS OF LOGS--

MEAN DIFFERENCE 0.35133E-01

T-STATISTIC 1.93

STD DEV 0.13027

DEGREES OF FREEDOM 50

TABLE V. - Continued. TOTAL SUSPENDED PARTICULATE (TSP) CONCENTRATIONS FOR GLASS FIBER AND WHATMAN-41 FILTERS

(m) Station 15

DATE	W41	GF	GF-W41	LOG(W41)	LOG(GF)	LOG(GF)-LOG(W41)	
8 16 71	96.00	98.00	2.00	1.9823	1.9912	0.89550E-02	1
8 18 71	134.00	293.00	159.00	2.1271	2.4669	0.33976	2
8 22 71	131.00	124.00	-7.00	2.1173	2.0934	-0.23849E-01	3
8 25 71	170.00	176.00	6.00	2.2304	2.2455	0.15063E-01	4
8 28 71	82.00	70.00	-12.00	1.9138	1.8451	-0.68716E-01	5
8 31 71	209.00	201.00	-8.00	2.3201	2.3032	-0.16950E-01	6
9 6 71	271.00	217.00	-54.00	2.4330	2.3365	-0.96510E-01	7
9 12 71	72.00	47.00	-25.00	1.8573	1.6721	-0.18524	8
9 15 71	298.00	270.00	-28.00	2.4742	2.4314	-0.42853E-01	9
9 18 71	145.00	161.00	16.00	2.1614	2.2068	0.45458E-01	10
9 24 71	64.00	96.00	32.00	1.8062	1.9823	0.17609	11
9 30 71	245.00	311.00	66.00	2.3892	2.4926	0.10359	12
10 2 71	214.00	241.00	27.00	2.3304	2.3820	0.51602E-01	13
10 6 71	46.00	49.00	3.00	1.6628	1.6902	0.27439E-01	14
10 9 71	63.00	61.00	-2.00	1.7993	1.7853	-0.14010E-01	15
10 12 71	116.00	135.00	19.00	2.0645	2.1303	0.65875E-01	16
10 18 71	319.00	346.00	27.00	2.5038	2.5391	0.35285E-01	17
10 21 71	301.00	319.00	18.00	2.4786	2.5038	0.25225E-01	18
10 27 71	264.00	265.00	1.00	2.4216	2.4232	0.16422E-02	19
10 30 71	385.00	429.00	44.00	2.5855	2.6325	0.46996E-01	20
11 2 71	90.00	83.00	-7.00	1.9542	1.9191	-0.35164E-01	21
11 5 71	130.00	182.00	52.00	2.1139	2.2601	0.14613	22
11 11 71	98.00	132.00	34.00	1.9912	2.1206	0.12935	23
11 17 71	267.00	372.00	105.00	2.4265	2.5705	0.14403	24
12 2 71	128.00	95.00	-33.00	2.1072	1.9777	-0.12949	25
12 5 71	178.00	161.00	-17.00	2.2504	2.2068	-0.43593E-01	26
12 8 71	68.00	83.00	15.00	1.8325	1.9191	0.86570E-01	27
12 11 71	109.00	130.00	21.00	2.0374	2.1139	0.76517E-01	28
12 20 71	51.00	60.00	9.00	1.7076	1.7782	0.70580E-01	29
12 26 71	47.00	38.00	-9.00	1.6721	1.5798	-0.92314E-01	30
1 7 72	41.00	53.00	12.00	1.6128	1.7243	0.11149	31
4 15 72	101.60	182.00	80.40	2.0069	2.2601	0.25319	32
4 18 72	190.80	208.00	17.20	2.2806	2.3181	0.37492E-01	33
4 21 72	188.60	195.00	6.40	2.2755	2.2900	0.14498E-01	34
4 27 72	116.40	130.00	13.60	2.0659	2.1139	0.47997E-01	35
4 30 72	194.20	216.00	21.80	2.2882	2.3345	0.46206E-01	36
5 3 72	84.30	91.00	6.70	1.9258	1.9590	0.33230E-01	37
5 6 72	192.60	195.00	2.40	2.2847	2.2900	0.53835E-02	38
5 15 72	94.90	100.00	5.10	1.9773	2.0000	0.22741E-01	39
5 18 72	100.10	190.00	89.90	2.0004	2.2788	0.27833	40
5 21 72	156.60	159.00	2.40	2.1948	2.2014	0.66118E-02	41
5 24 72	220.40	253.00	32.60	2.3432	2.4031	0.59912E-01	42
5 27 72	250.70	253.00	2.30	2.3992	2.4031	0.39673E-02	43
6 2 72	112.00	117.00	5.00	2.0492	2.0682	0.18968E-01	44
6 8 72	123.20	108.00	-15.20	2.0906	2.0334	-0.57184E-01	45
6 17 72	104.20	101.00	-3.20	2.0179	2.0043	-0.13543E-01	46
7 8 72	84.70	127.00	42.30	1.9279	2.1038	0.17592	47
7 11 72	127.60	138.00	10.40	2.1058	2.1399	0.34037E-01	48
7 29 72	100.20	108.00	7.80	2.0009	2.0334	0.32559E-01	49
8 1 72	102.70	62.00	-40.70	2.0116	1.7924	-0.21918	50
8 10 72	63.10	120.00	56.90	1.8000	2.0792	0.27917	51
8 13 72	178.50	213.00	34.50	2.2516	2.3284	0.76742E-01	52
8 16 72	243.30	198.00	-45.30	2.3861	2.2967	-0.89471E-01	53
8 19 72	112.70	115.00	2.30	2.0519	2.0607	0.87767E-02	54
8 25 72	87.10	128.00	40.90	1.9400	2.1072	0.16720	55
9 3 72	36.30	31.00	-5.30	1.5599	1.4914	-0.68508E-01	56
9 6 72	151.00	153.00	2.00	2.1790	2.1847	0.57144E-02	57
9 9 72	40.20	46.00	5.80	1.6042	1.6628	0.58539E-01	58
9 12 72	166.00	205.00	39.00	2.2201	2.3118	0.91646E-01	59
9 18 72	72.00	86.00	14.00	1.8573	1.9345	0.77166E-01	60
9 21 72	156.90	158.00	1.10	2.1956	2.1987	0.30394E-02	61
9 24 72	87.40	82.00	-5.40	1.9415	1.9138	-0.27690E-01	62
MEAN	143.10	157.52				0.37459E-01	

CORRELATION COEFFICIENT 0.917

COEFFICIENTS OF BEST FITTING STRAIGHT LINE --FIRST SET IS NOT FORCED THROUGH ORIGIN, SECOND SET IS FORCED

INTERCEPT	SLOPE	ERROR STD DEV
-2.94	1.121	24.06
0.00	1.105	23.88

T VALUE FOR TEST OF BETA 2.0 DEGREES OF FREEDOM 60

ANALYSIS OF LOGS--
MEAN DIFFERENCE 0.37459E-01
T-STATISTIC 2.39
STD DEV 0.10201
DEGREES OF FREEDOM 61

TABLE V. - Continued. TOTAL SUSPENDED PARTICULATE (TSP) CONCENTRATIONS FOR GLASS FIBER AND WHATMAN-41 FILTERS

(n) Station 17

DATE	W41	GF	GF-W41	LOG(W41)	LOG(GF)	LOG(GF)-LOG(W41)	
8 10 71	233.00	232.00	-1.00	2.3674	2.3655	-0.18673E-02	1
8 22 71	149.00	139.00	-10.00	2.1732	2.1430	-0.30171E-01	2
8 25 71	192.00	207.00	15.00	2.2833	2.3160	0.32670E-01	3
8 28 71	194.00	187.00	-7.00	2.2878	2.2718	-0.15961E-01	4
8 31 71	191.00	181.00	-10.00	2.2810	2.2577	-0.23355E-01	5
9 6 71	159.00	125.00	-34.00	2.2014	2.0969	-0.10449	6
9 9 71	148.00	123.00	-25.00	2.1703	2.0899	-0.80357E-01	7
9 15 71	177.00	174.00	-3.00	2.2480	2.2405	-0.74234E-02	8
9 18 71	102.00	104.00	2.00	2.0086	2.0170	0.84343E-02	9
9 24 71	103.00	103.00	0.00	2.0128	2.0128	0.00000	10
9 30 71	100.00	124.00	24.00	2.0000	2.0934	0.93422E-01	11
10 2 71	107.00	132.00	25.00	2.0294	2.1206	0.91190E-01	12
10 6 71	110.00	106.00	-4.00	2.0414	2.0253	-0.16087E-01	13
10 9 71	70.00	68.00	-2.00	1.8451	1.8325	-0.12589E-01	14
10 12 71	172.00	163.00	-9.00	2.2355	2.2122	-0.23341E-01	15
12 11 71	99.00	100.00	1.00	1.9956	2.0000	0.43650E-02	16
12 14 71	121.00	121.00	0.00	2.0828	2.0828	0.00000	17
12 26 71	74.00	64.00	-10.00	1.8692	1.8062	-0.63051E-01	18
1 7 72	100.00	113.00	13.00	2.0000	2.0531	0.53078E-01	19
1 16 72	86.00	88.00	2.00	1.9345	1.9445	0.99850E-02	20
1 19 72	108.00	148.00	40.00	2.0334	2.1703	0.13684	21
1 22 72	82.00	83.00	1.00	1.9138	1.9191	0.52643E-02	22
1 28 72	96.00	135.00	39.00	1.9823	2.1303	0.14806	23
2 21 72	216.80	185.00	-31.80	2.3361	2.2672	-0.68881E-01	24
2 24 72	65.20	106.00	40.80	1.8142	2.0253	0.21106	25
2 27 72	167.90	179.00	11.10	2.2250	2.2529	0.27806E-01	26
3 1 72	154.50	127.00	-27.50	2.1889	2.1038	-0.85125E-01	27
3 16 72	131.10	164.00	32.90	2.1176	2.2148	0.97249E-01	28
3 19 72	114.10	121.00	6.90	2.0573	2.0828	0.25509E-01	29
3 22 72	89.20	89.00	-0.20	1.9504	1.9494	-0.97179E-03	30
3 25 72	33.60	72.00	38.40	1.5263	1.8573	0.33102	31
3 29 72	84.80	133.00	48.20	1.9284	2.1239	0.19547	32
4 3 72	177.00	155.00	-22.00	2.2480	2.1903	-0.57641E-01	33
4 6 72	157.10	177.00	19.90	2.1962	2.2480	0.51803E-01	34
4 9 72	144.20	128.00	-16.20	2.1590	2.1072	-0.51754E-01	35
4 12 72	232.50	228.00	-4.50	2.3664	2.3579	-0.84877E-02	36
4 15 72	157.10	181.00	23.90	2.1962	2.2577	0.61508E-01	37
4 18 72	169.70	174.00	4.30	2.2297	2.2405	0.10870E-01	38
4 27 72	113.10	129.00	15.90	2.0535	2.1106	0.57137E-01	39
4 30 72	180.20	138.00	-42.20	2.2558	2.1399	-0.11587	40
5 3 72	159.20	153.00	-6.20	2.2019	2.1847	-0.17249E-01	41
5 6 72	264.25	241.00	-23.25	2.4220	2.3820	-0.39999E-01	42
5 15 72	149.60	145.00	-4.60	2.1749	2.1614	-0.13556E-01	43
5 18 72	228.10	236.00	7.90	2.3581	2.3729	0.14791E-01	44
5 21 72	204.60	169.00	-35.60	2.3109	2.2279	-0.83014E-01	45
5 24 72	217.30	234.00	16.70	2.3371	2.3692	0.32163E-01	46
5 27 72	207.80	176.00	-31.80	2.3176	2.2455	-0.72126E-01	47
6 2 72	177.60	164.00	-13.60	2.2494	2.2148	-0.34594E-01	48
6 8 72	279.38	193.00	-86.38	2.4462	2.2856	-0.16063	49
6 11 72	98.10	110.00	11.90	1.9917	2.0414	0.49734E-01	50
6 17 72	123.30	111.00	-12.30	2.0910	2.0453	-0.45630E-01	51
6 20 72	171.80	123.00	-48.80	2.2350	2.0899	-0.14511	52
6 29 72	122.70	160.00	37.30	2.0888	2.2041	0.11528	53
7 2 72	114.40	166.00	51.60	2.0584	2.2201	0.16169	54
7 11 72	206.20	215.00	8.80	2.3143	2.3324	0.18151E-01	55
7 14 72	153.30	147.00	-6.30	2.1855	2.1673	-0.18215E-01	56
7 20 72	209.00	187.00	-22.00	2.3201	2.2718	-0.48305E-01	57
7 29 72	90.60	179.00	88.40	1.9571	2.2529	0.29574	58
8 1 72	204.80	243.00	38.20	2.3113	2.3856	0.74283E-01	59
8 7 72	107.30	116.00	8.70	2.0306	2.0645	0.33872E-01	60
8 10 72	92.00	126.00	34.00	1.9638	2.1004	0.13658	61
8 13 72	161.10	146.00	-15.10	2.2071	2.1644	-0.42736E-01	62
8 16 72	143.60	125.00	-18.60	2.1571	2.0969	-0.60238E-01	63
8 25 72	111.80	116.00	4.20	2.0484	2.0645	0.16028E-01	64
8 31 72	148.40	136.00	-12.40	2.1714	2.1335	-0.37890E-01	65
9 3 72	57.00	32.00	-25.00	1.7559	1.5051	-0.25072	66
9 9 72	64.10	59.00	-5.10	1.8068	1.7709	-0.35990E-01	67
9 18 72	60.30	72.00	11.70	1.7803	1.8573	0.77038E-01	68
9 21 72	103.30	99.00	-4.30	2.0141	1.9956	-0.18452E-01	69
9 24 72	105.10	98.00	-7.10	2.0216	1.9912	-0.30367E-01	70

MEAN 141.39 142.61 0.10798E-01

CORRELATION COEFFICIENT 0.866

COEFFICIENTS OF BEST FITTING STRAIGHT LINE --FIRST SET IS NOT FORCED THROUGH ORIGIN, SECOND SET IS FORCED

INTERCEPT	SLOPE	ERROR STD DEV
20.64	0.863	18.42
0.00	0.994	18.93

T VALUE FOR TEST OF BETA 2.1 DEGREES OF FREEDOM 68

ANALYSIS OF LOGS--

MEAN DIFFERENCE 0.10798E-01

T-STATISTIC 0.95

STD DEV 0.95098E-01

DEGREES OF FREEDOM 69

TABLE V. - Continued. TOTAL SUSPENDED PARTICULATE (TSP) CONCENTRATIONS FOR GLASS FIBER AND WHATMAN-41 FILTERS

(o) Station 20

DATE	W41	GF	GF-W41	LOG (W41)	LOG (GF)	LOG (GF) - LOG (W41)	
8 10 71	170.00	162.00	-8.00	2.2304	2.2095	-0.20934E-01	1
8 22 71	85.00	87.00	2.00	1.9294	1.9395	0.10100E-01	2
6 25 71	101.00	97.00	-4.00	2.0043	1.9868	-0.17550E-01	3
6 28 71	67.00	45.00	-22.00	1.8261	1.6532	-0.17286	4
6 31 71	93.00	73.00	-20.00	1.9685	1.8633	-0.10516	5
9 6 71	124.00	79.00	-45.00	2.0934	1.8976	-0.19580	6
9 9 71	123.00	108.00	-15.00	2.0899	2.0334	-0.56481E-01	7
9 15 71	117.00	93.00	-24.00	2.0682	1.9685	-0.99703E-01	8
9 18 71	60.00	57.00	-3.00	1.7782	1.7559	-0.22276E-01	9
9 24 71	43.00	52.00	9.00	1.6335	1.7160	0.82535E-01	10
9 30 71	107.00	114.00	7.00	2.0294	2.0569	0.27521E-01	11
10 6 71	48.00	50.00	2.00	1.6812	1.6990	0.17729E-01	12
10 9 71	54.00	50.00	-4.00	1.7324	1.6990	-0.33423E-01	13
10 12 71	103.00	89.00	-14.00	2.0128	1.9494	-0.63447E-01	14
10 18 71	145.00	129.00	-16.00	2.1614	2.1106	-0.50778E-01	15
10 21 71	151.00	119.00	-32.00	2.1790	2.0755	-0.10343	16
10 30 71	182.00	186.00	4.00	2.2601	2.2695	0.94414E-02	17
12 8 71	103.00	109.00	6.00	2.0128	2.0374	0.24590E-01	18
12 14 71	101.00	104.00	3.00	2.0043	2.0170	0.12712E-01	19
12 20 71	13.00	46.00	33.00	1.1139	1.6628	0.54881	20
12 26 71	56.00	56.00	0.00	1.7482	1.7482	0.00000	21
1 4 72	16.00	70.00	54.00	1.2041	1.8451	0.64098	22
1 13 72	32.00	40.00	8.00	1.5051	1.6021	0.96910E-01	23
2 12 72	212.90	177.00	-35.90	2.3282	2.2460	-0.80199E-01	24
2 15 72	38.10	38.00	-0.10	1.5809	1.5798	-0.11148E-02	25
2 24 72	114.20	57.00	-57.20	2.0577	1.7559	-0.30179	26
2 27 72	130.30	105.00	-25.30	2.1149	2.0212	-0.93745E-01	27
5 3 72	70.10	72.00	1.90	1.8457	1.8573	0.11629E-01	28
5 6 72	95.80	111.00	15.20	1.9814	2.0453	0.63972E-01	29
5 9 72	65.00	42.00	-23.00	1.8129	1.6232	-0.18966	30
5 15 72	70.60	73.00	2.40	1.8488	1.8633	0.14532E-01	31
5 18 72	125.60	129.00	3.40	2.0990	2.1106	0.11609E-01	32
5 21 72	86.30	113.00	26.70	1.9360	2.0531	0.11708	33
5 24 72	125.70	174.00	48.30	2.0993	2.2405	0.14122	34
5 27 72	47.10	106.00	58.90	1.6730	2.0253	0.35231	35
6 2 72	120.80	110.00	-10.80	2.0821	2.0414	-0.40663E-01	36
6 6 72	106.90	107.00	0.10	2.0290	2.0294	0.41294E-03	37
6 11 72	32.90	56.00	23.10	1.5172	1.7482	0.23101	38
6 14 72	29.20	91.00	61.80	1.4654	1.9590	0.49367	39
6 17 72	77.60	65.00	-12.60	1.8898	1.8129	-0.76935E-01	40
6 20 72	45.60	73.00	27.40	1.6589	1.8633	0.20436	41
6 26 72	49.30	71.00	21.70	1.6928	1.8513	0.15844	42
7 2 72	62.50	89.00	26.50	1.7959	1.9494	0.15351	43
7 14 72	74.50	76.00	1.50	1.8722	1.8808	0.86575E-02	44
7 20 72	76.00	137.00	61.00	1.8808	2.1367	0.25591	45
8 10 72	34.30	94.00	59.70	1.5353	1.9731	0.43787	46
8 13 72	100.20	117.00	16.80	2.0009	2.0682	0.67322E-01	47
6 16 72	79.00	96.00	17.00	1.8976	1.9823	0.84644E-01	48
8 19 72	82.70	68.00	-14.70	1.9175	1.8325	-0.84992E-01	49
8 22 72	45.80	101.00	55.20	1.6608	2.0043	0.34349	50
9 6 72	154.20	151.00	-3.20	2.1881	2.1790	-0.91047E-02	51
9 12 72	98.70	131.00	32.30	1.9943	2.1173	0.12296	52
9 18 72	72.00	46.00	-26.00	1.8573	1.6628	-0.19458	53
9 21 72	77.60	84.00	6.40	1.8898	1.9243	0.34431E-01	54
9 24 72	52.30	76.00	23.70	1.7165	1.8808	0.16234	55

MEAN 86.32 91.84 0.53238E-01

CORRELATION COEFFICIENT 0.771

COEFFICIENTS OF BEST FITTING STRAIGHT LINE --FIRST SET IS NOT FORCED THROUGH ORIGIN, SECOND SET IS FORCED

INTERCEPT	SLOPE	ERROR STD DEV
21.64	0.813	18.84
0.00	1.028	19.65

T VALUE FOR TEST OF BETA 1.8 DEGREES OF FREEDOM 53

ANALYSIS OF LOGS--

MEAN DIFFERENCE 0.53238E-01

T-STATISTIC 2.13

STD DEV 0.18564

DEGREES OF FREEDOM 54

TABLE V. - Concluded. TOTAL SUSPENDED PARTICULATE (TSP) CONCENTRATIONS FOR GLASS FIBER AND WHATMAN-41 FILTERS

(p) Station 21

DATE	W41	GF	GF-W41	LOG (W41)	LOG (GF)	LOG (GF) - LOG (W41)	
8 10 71	171.00	171.00	0.00	2.2330	2.2330	0.00000	1
8 25 71	277.00	272.00	-5.00	2.4425	2.4346	-0.79107E-02	2
8 28 71	95.00	87.00	-8.00	1.9777	1.9395	-0.38204E-01	3
8 31 71	105.00	89.00	-16.00	2.0212	1.9494	-0.71799E-01	4
9 16 71	209.00	259.00	50.00	2.3201	2.4133	0.93154E-01	5
9 24 71	114.00	129.00	15.00	2.0569	2.1106	0.53685E-01	6
9 30 71	163.00	207.00	44.00	2.2122	2.3160	0.10378	7
10 6 71	62.00	73.00	11.00	1.7924	1.8633	0.70930E-01	8
1 4 72	86.00	118.00	32.00	1.9345	2.0719	0.13738	9
1 7 72	75.00	59.00	-16.00	1.8751	1.7709	-0.10421	10
1 13 72	61.00	86.00	25.00	1.7853	1.9345	0.14917	11
1 16 72	61.00	63.00	2.00	1.7853	1.7993	0.14010E-01	12
1 19 72	56.00	83.00	27.00	1.7482	1.9191	0.17089	13
1 25 72	247.00	238.00	-9.00	2.3927	2.3766	-0.16120E-01	14
1 28 72	64.00	103.00	39.00	1.8062	2.0128	0.20666	15
2 3 72	115.20	179.00	63.80	2.0614	2.2529	0.19140	16
2 15 72	59.80	73.00	13.20	1.7767	1.8633	0.86644E-01	17
2 21 72	252.90	255.00	2.10	2.4029	2.4065	0.35944E-02	18
2 24 72	81.80	79.00	-2.80	1.9127	1.8976	-0.15109E-01	19
2 27 72	153.00	144.00	-9.00	2.1847	2.1584	-0.26329E-01	20
3 1 72	264.00	272.00	8.00	2.4216	2.4346	0.12965E-01	21
3 4 72	145.10	234.00	88.90	2.1617	2.3692	0.20756	22
4 9 72	67.20	112.00	44.80	1.8274	2.0492	0.22185	23
4 12 72	237.70	320.00	82.30	2.3760	2.5051	0.12912	24
4 18 72	281.19	387.00	105.81	2.4490	2.5877	0.13871	25
4 30 72	229.40	308.00	78.60	2.3606	2.4886	0.12796	26
5 3 72	93.80	116.00	22.20	1.9722	2.0645	0.92270E-01	27
5 6 72	249.90	296.00	46.10	2.3978	2.4713	0.73528E-01	28
5 9 72	102.80	85.00	-17.80	2.0120	1.9294	-0.82561E-01	29
5 15 72	102.10	198.00	95.90	2.0090	2.2967	0.28765	30
5 18 72	119.60	184.00	64.40	2.0777	2.2648	0.18709	31
5 21 72	146.10	201.00	54.90	2.1646	2.3032	0.13855	32
5 24 72	241.70	362.00	120.30	2.3833	2.5587	0.17543	33
5 27 72	212.30	263.00	50.70	2.3269	2.4200	0.93012E-01	34
6 2 72	128.40	220.00	91.60	2.1086	2.3424	0.23386	35
6 8 72	145.00	184.00	39.00	2.1614	2.2648	0.10345	36
6 11 72	91.80	134.00	42.20	1.9628	2.1271	0.16428	37
6 14 72	114.90	141.00	26.10	2.0603	2.1492	0.88905E-01	38
6 17 72	112.00	79.00	-33.00	2.0492	1.8976	-0.15159	39
6 20 72	266.06	270.00	3.94	2.4250	2.4314	0.63791E-02	40
6 29 72	125.30	147.00	21.70	2.0979	2.1673	0.69378E-01	41
7 2 72	143.90	191.00	47.10	2.1581	2.2610	0.12298	42
7 29 72	78.60	107.00	28.40	1.8954	2.0294	0.13397	43
8 1 72	127.50	184.00	56.50	2.1055	2.2648	0.15931	44
8 10 72	116.10	164.00	47.90	2.0648	2.2148	0.15002	45
8 13 72	281.88	293.00	11.13	2.4501	2.4669	0.16811E-01	46
8 16 72	284.50	258.00	-26.50	2.4541	2.4116	-0.42462E-01	47
8 19 72	271.38	72.00	-199.38	2.4336	1.8573	-0.57624	48
8 22 72	416.06	403.00	-13.06	2.6192	2.6053	-0.13653E-01	49
8 25 72	93.00	111.00	18.00	1.9685	2.0453	0.76839E-01	50
9 3 72	41.50	39.00	-2.50	1.6180	1.5911	-0.26983E-01	51
9 6 72	229.80	255.00	25.20	2.3613	2.4065	0.45196E-01	52
9 9 72	52.60	47.00	-5.60	1.7210	1.6721	-0.48669E-01	53
9 18 72	233.10	181.00	-52.10	2.3675	2.2577	-0.10986	54
9 21 72	275.00	316.00	41.00	2.4393	2.4997	0.60355E-01	55
9 24 72	116.00	107.00	-9.00	2.0645	2.0294	-0.35074E-01	56
MEAN	156.18	178.71				0.57707E-01	

CORRELATION COEFFICIENT 0.862

COEFFICIENTS OF BEST FITTING STRAIGHT LINE --FIRST SET IS NOT FORCED THROUGH ORIGIN, SECOND SET IS FORCED

INTERCEPT	SLOPE	ERROR STD DEV
3.46	1.122	33.25
0.00	1.140	32.97

T VALUE FOR TEST OF BETA 1.4 DEGREES OF FREEDOM 54

ANALYSIS OF LOGS--

MEAN DIFFERENCE 0.57707E-01

T-STATISTIC 3.32

STD DEV 0.13005

DEGREES OF FREEDOM 55

TABLE VI. - SUMMARY OF ESTIMATED OF BEST-FITTING TONES AT EACH STATION

Station	Number of observation	α	β	t
1	57	16.45	1.014	0.2
3	91	-8.46	1.307	[a]7.5
5	66	-.11	1.109	1.2
6	54	10.67	.800	-1.3
7	84	-1.74	.976	-.5
8	75	-3.36	.979	-.2
10	73	6.11	.999	0
12	71	-5.83	1.271	[a]2.9
14	51	11.19	.926	-.5
15	62	-2.94	1.121	[a]2.0
17	70	20.64	.863	[a]-2.1
20	55	21.64	.813	-1.8
21	56	3.46	1.122	1.4
4	53	28.49	.534	-7.6
9	76	-67.85	2.222	7.2
13	48	107.74	.463	-3.8

[a]t-Statistics indicate $\hat{\beta}$ values significantly different from 1.0 at 95 percent significance level.

TABLE VII. - SAMPLE DISTRIBUTION OF $\overline{m}_j$

Number of observations, j	Station	$\overline{m}_j$	Sample distribution function, $\left(j - \frac{1}{2}\right)/14$
1	4	-0.1023	0.0357
2	6	-.0448	.1071
3	8	-.0194	.1786
4	7	-.0181	.2500
5	17	.0108	.3214
6	10	.0248	.3929
7	14	.0351	.4643
8	15	.0375	.5357
9	1	.0453	.6071
10	5	.0459	.6786
11	20	.0532	.7500
12	21	.0577	.8214
13	12	.0744	.8929
14	3	.0859	.9643
15	9	.2228	------
16	13	.0670	------
		$\overline{\overline{m}}$ = .0204	

1 Air Pollution Control Office, 2785 Broadway
2 Audubon Junior High School, 3055 East Boulevard
3 Brooklyn Y. M. C. A., West 25 St. and Denison
4 Cleveland Health Museum, 8911 Euclid
5 Cleveland Pneumatic Tool, 3701 East 71 (near Broadway)
6 Collinwood High School, East 152 and St. Clair
7 Cudell Recreation Center, West Boulevard and Detroit
8 Estabrook Recreation Center, Fulton and Memphis
9 Fire Station 13, 4749 Broadway
10 Fire Station 19, East 55 and St. Clair
11 St. Vincent Charity Hospital, E. 22 St.
12 G. Washington Elementary School, 16210 Lorain
13 Harvard Yards, 4150 East 49 St.
14 J. F. Kennedy High School, 17100 Harvard
15 P. L. Dunbar Elementary School, 2200 West 28 St.
16 Almira Elementary School, West 98 St. and Almira
17 Fire Station 29, East 105 St. and Superior
18 John Adams High School, 3817 East 116 St.
19 J. F. Rhodes High School, 5100 Biddulph
20 St. Joseph High School, 18491 Lake Shore Blvd.
21 Supplementary Education Center, 1365 E. 12 St.

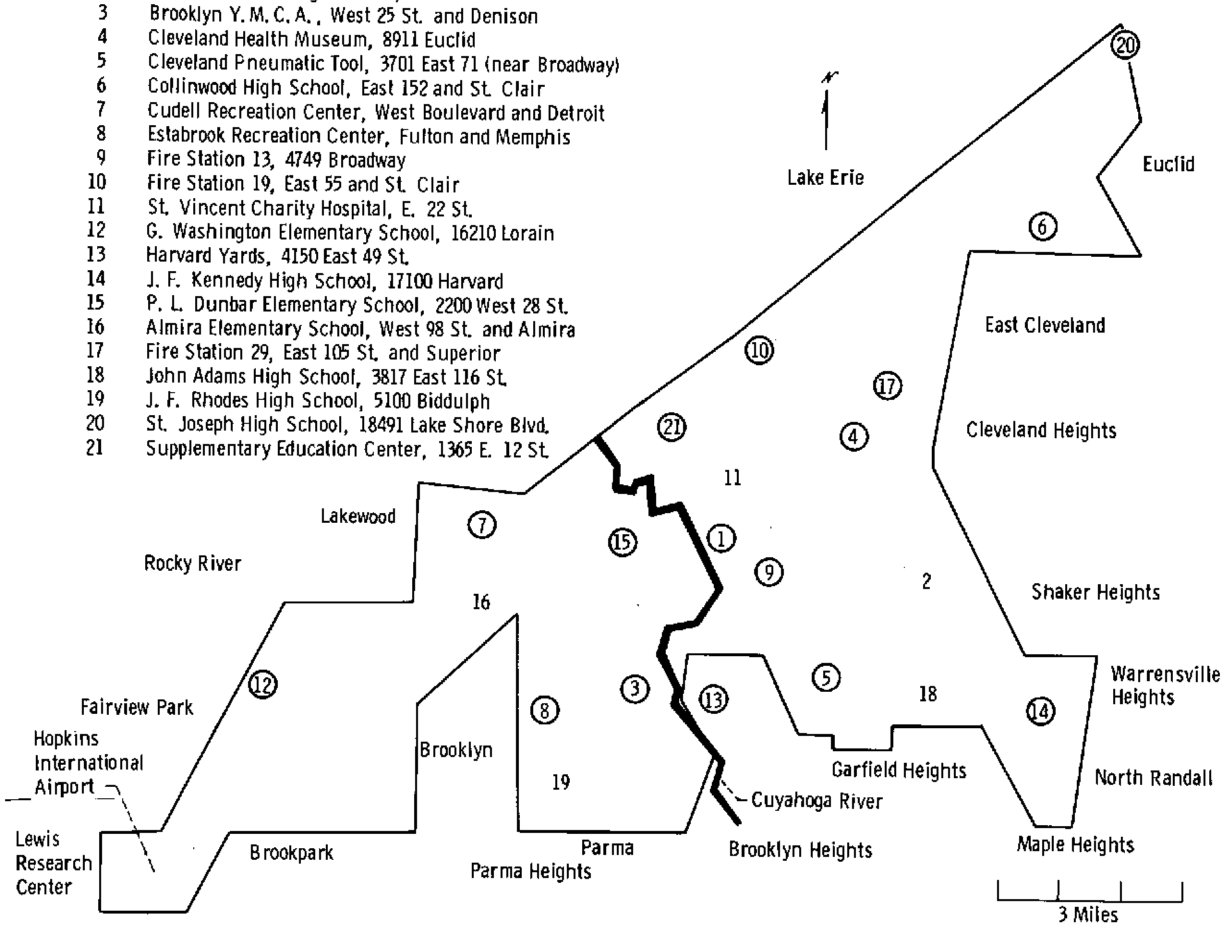


Figure 1. - Air pollution monitoring sites for Cleveland, Ohio. Sixteen circled sites constitute the parallel network considered in this report. Municipal boundaries have been straightened somewhat but are accurate in their essential features.

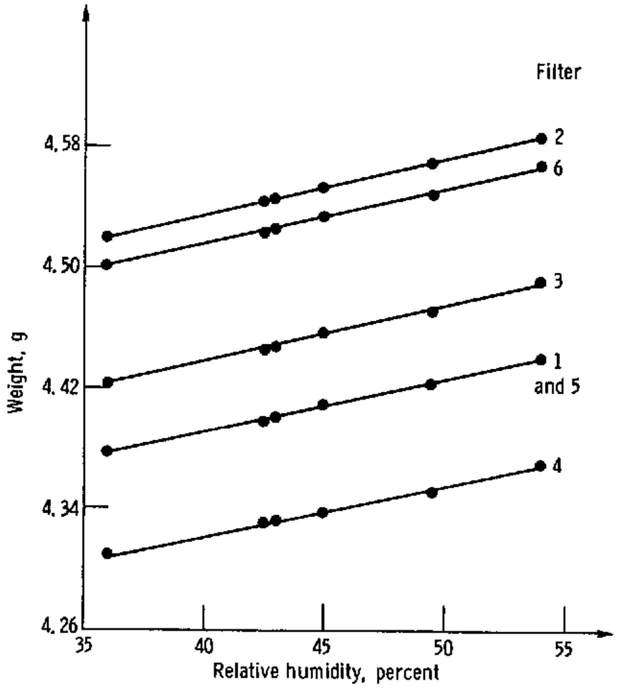
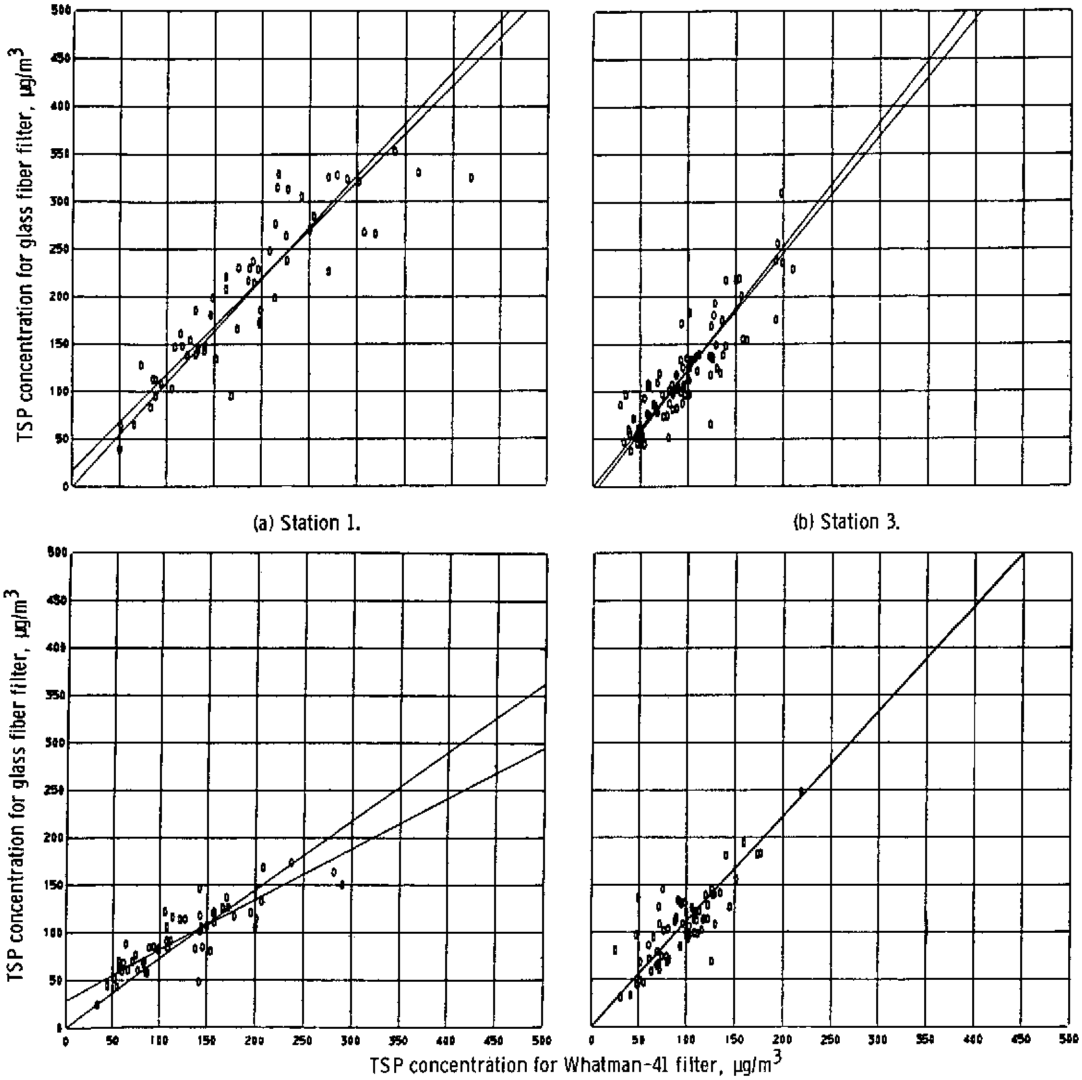


Figure 2. - Plots of weight in grams of six Whatman-41 filters as function of relative humidity.



(a) Station 1.

(b) Station 3.

(c) Station 4.

(d) Station 5.

Figure 3. - Plots of total suspended particulate (TSP) concentrations for glass fiber and Whatman-41 filters for 16 stations. Two curves are best-fit lines with one of lines forced through the origin.

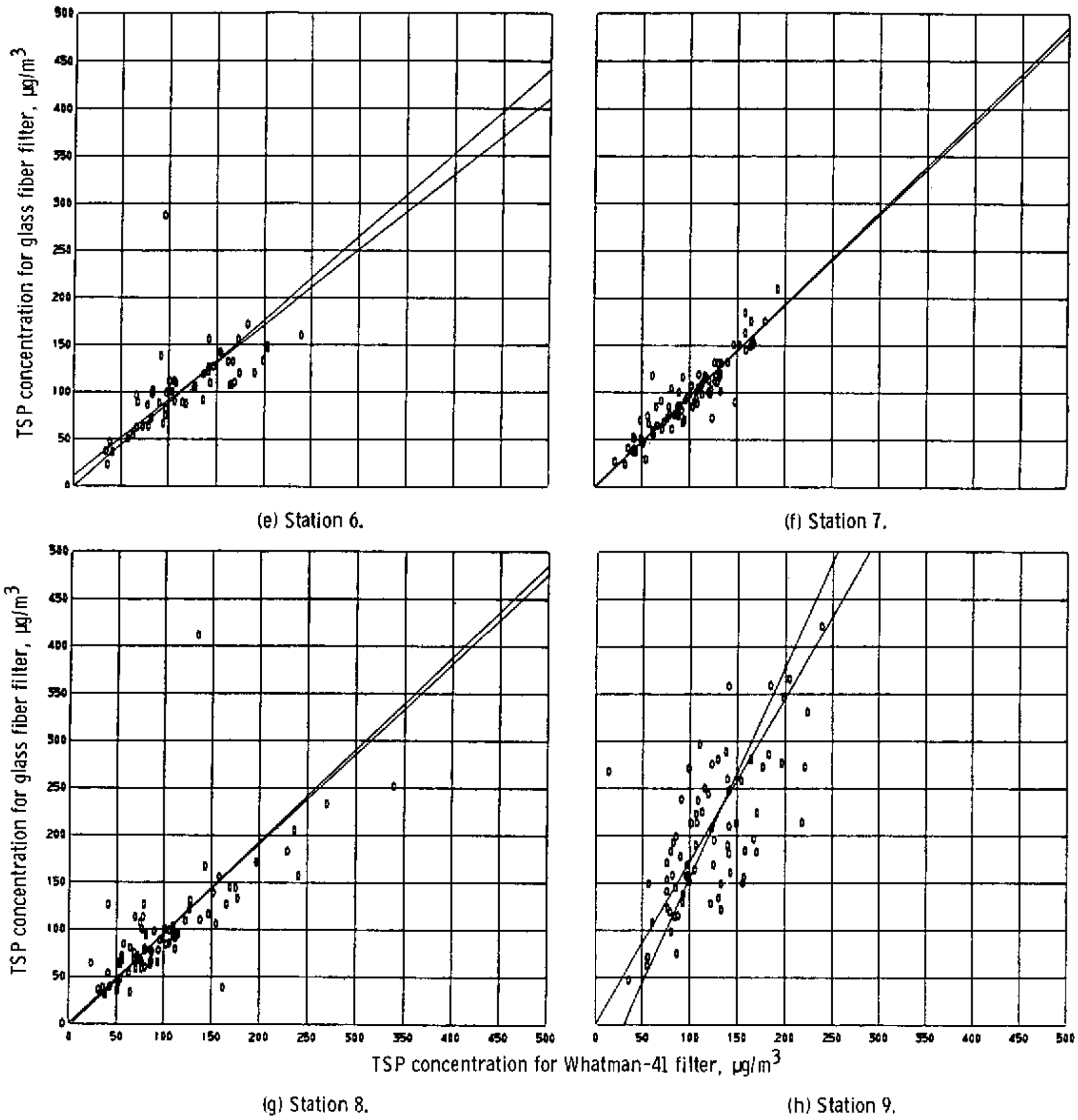
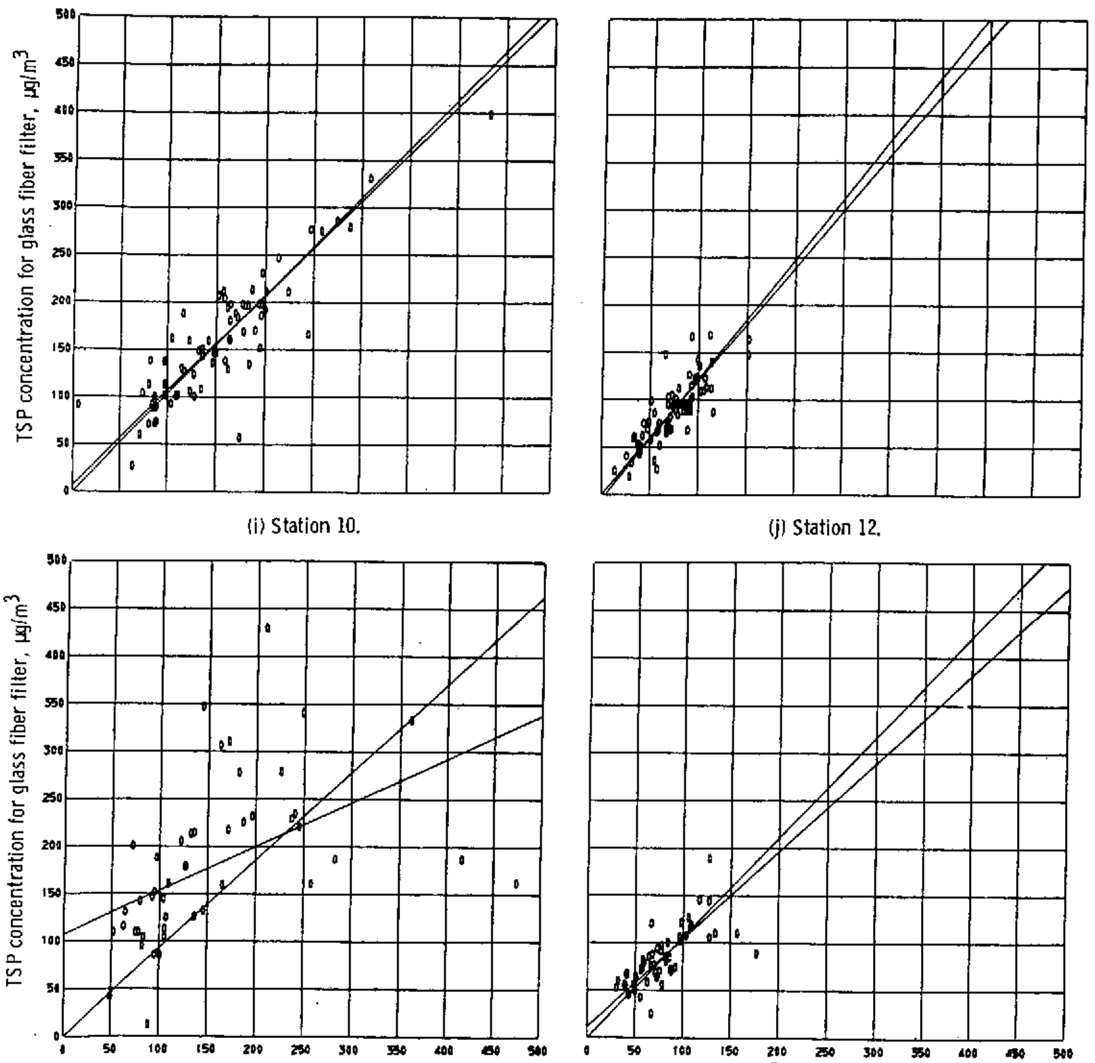


Figure 3. - Continued.



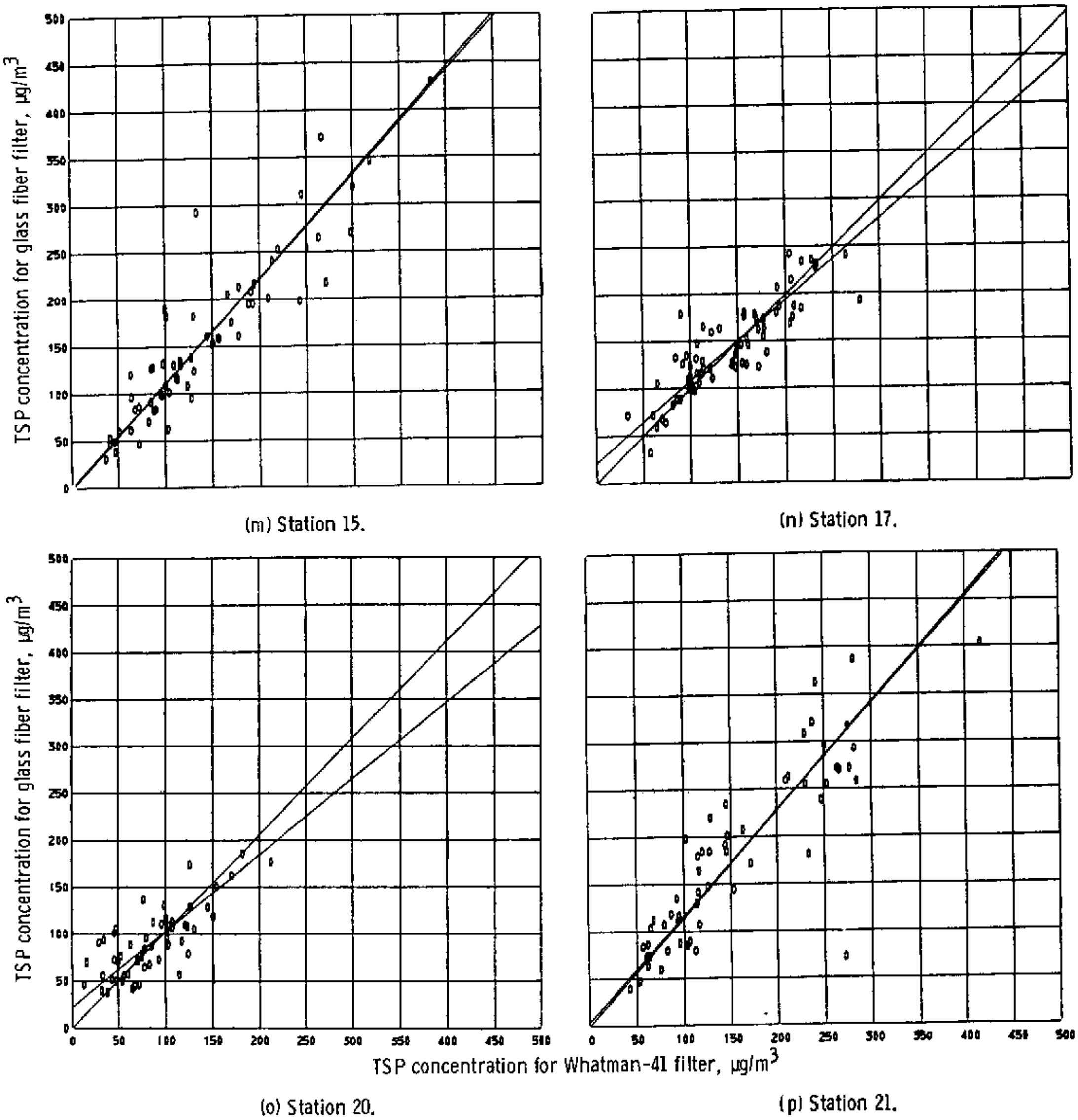
(i) Station 10.

(j) Station 12.

(k) Station 13.

(ℓ) Station 14.

Figure 3. - Continued.



(m) Station 15.

(n) Station 17.

(o) Station 20.

(p) Station 21.

Figure 3. - Concluded.

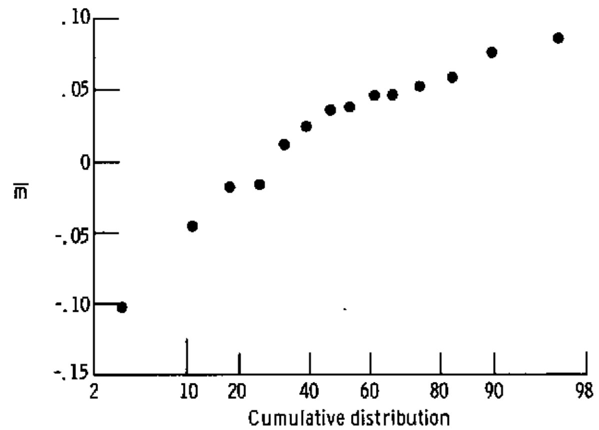


Figure 4. - Normal probability plot of $\overline{m}$ values.